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LECTOTYPIFICATIONS OF THE TYPES OF *ERIOGONUM* A. MICHX. AND *CHORIZANTHE* R. BR. *EX* BENTH. (POLYGONACEAE: ERIOGONOIDEAE)

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ABSTRACT

Lectotypes are designated for *Eriogonum tomentosum* A. Michx. and *Chorizanthe virgata* Benth., the type species of each genus. An unnumbered Michaux specimen from South Carolina or Georgia in the Jussieu herbarium (P-JU) is designated as the lectotype of *E. tomentosum*. A Cuming specimen from Chile, *Cuming 205*, in the Bentham herbarium (K) is designated as the lectotype of *C. virgata*.

KEY WORDS: *Eriogonum*, *Chorizanthe*, Polygonaceae, nomenclature

In reviewing the genera of Polygonaceae subf. Eriogonoideae for the listing of generic names in current use (Greuter *et al.*, 1991a, b), I realized that lectotypes for the type species of *Eriogonum* A. Michx. (1803: 246) and *Chorizanthe* R. Br. *ex* Benth. (1836: 405, 416) had never been designated. As *Eriogonum* was monospecific when proposed, the type of the genus is *E. tomentosum*. Goodman (1934: 19) designated *C. virgata* as the lectotype of *Chorizanthe*, one of several species proposed by Bentham in 1836.

Designation of a logical lectotype for *Eriogonum tomentosum* is difficult because Michaux indicated that he knew the species from "Carolinae et Georgiae", meaning that there might be material from more than one collection site included among his herbarium material of the species. The Michaux herbarium is maintained as a separate herbarium at the Muséum National d'Histiore Naturelle in Paris. In Michaux's herbarium there is a perfectly adequate specimen of *E. tomentosum* which lacks location data and date of collection.

In the Jussieu herbarium at the Muséum is another Michaux specimen. This one was the basis of the Redouté illustration Michaux published when he proposed the genus. A note on the sheet indicates that Michaux loaned it to

Jussieu who promised its return. The fact that he failed to do so is recorded in another note by Michaux. It appears that Jussieu intended to describe the new genus, and may even have suggested the name *Eriogonum* for it. Like the specimen in the Michaux herbarium, the one in Jussieu's lacks distribution details.

I believe the two specimens (P-MICH and P-JU) are duplicates of the same collection, but I cannot prove this, especially so because of the two localities cited by Michaux. In Berlin (B), there is a fragment in the Koenpruss herbarium labeled "America Septentr. (Michaux) A. Richard Acd. 183-" which may or may not be a fragment of one of the Michaux sheets at Paris. Also, there is another unattributed specimen of *Eriogonum tomentosum* in the Jussieu herbarium, the origin of which is unknown. I am aware that Mark Catesby collected the species in the 1720's (BM-Sloane) as did Thomas Walter or John Fraser in the 1780's (BM), but if there are other pre-Michaux collections, I am unaware of them. None is nomenclaturally significant as Michaux knew the species only from his own material.

Because the Michaux specimen in the Jussieu herbarium can be directly associated with the illustration in the original publication, I hereby lectotypify *Eriogonum tomentosum* on *Michaux s.n.*, without location or date (P-JU).

Bentham (1836) cited *Cuming 205* and *Bridges 519* when he proposed *Chorizanthe virgata*, a perennial species of central and northern Chile. Bentham also illustrated the plant (Tab. XIX, f. 1). All of these elements may be regarded as original material. I hereby designate the Bentham sheet (K) of *Cuming 205* from Querto Portrero, Chile, as the lectotype of the species.

ACKNOWLEDGMENTS

I am grateful to Dr. Edward E. Terrell and John Wiersema for their comments. Work on the typification of North American vascular plants is supported by National Science Foundation Grant BSR-8812816. This is Scientific Article A-6310, Contribution No. 8484, of the Maryland Agricultural Experiment Station and Cooperative Extension Service.

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A NEW SPECIES OF *BRICKELLIA* (ASTERACEAE, EUPATORIEAE) FROM NORTHWESTERN MEXICO

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ABSTRACT

A new species of *Brickellia*, **B. gentryi** B. Turner, from Sierra Gamón, Durango, is described. It is related to *B. lanata* but has thinner, less tomentose leaves and drooping heads.

KEY WORDS: Asteraceae, Eupatorieae, *Brickellia*, México.

Among a group of unidentified *Brickellia* specimens sent to me for identification by MICH, the following novelty was discerned.

Brickellia gentryi B. Turner, *sp. nov.* TYPE: MEXICO. Durango: Sierra Gamón, Canyon Cantero, "Steep rocky volcanic slopes with oak, coarse grass; etc.," ca. 2000 m, 21 Sep 1948, *Howard Scott Gentry 8389* (HOLOTYPE: MICH!).

Brickelliae lanatae (DC.) A. Gray similis sed differt foliis tenuioribus minus tomentosis et capitulescentia racemosa laxa terminali 4-5 capitulis cernuis praeditis.

Suffruticose perennial herbs or shrublets, 50 cm high or more. Stems moderately tomentulose. Leaves opposite throughout, 3-6 cm long, 1.5-2.5 cm wide; petioles mostly 3-5(-6) mm long; blades ovate elliptic to elliptic, with 3 principal nerves arising from or near the base, otherwise reticulate venose, the lower surfaces only sparsely tomentulose, the margins serrate, the serrations not at all prickly. Heads 4-5, drooping, borne in loose terminal naked racemes, 2-3 at a node, the ultimate peduncles tomentulose, 5-15 mm long. Involucres turbocampanulate, 12-14 mm high, ca. 12 mm wide at midsection (pressed), the bracts 5-6 seriate, graduate, the outer series ovate, the inner series linear-lanceolate with obtuse-apiculate apices. Florets ca. 50 per head (estimated),

the corollas whitish, tubular, ca. 7 mm long. Achenes (immature) ca. 3.5 mm long, appressed pubescent, the pappus of ca. 30 white sparsely barbellate bristles 7-8 mm long.

This taxon superficially resembles *Brickellia lanata* (DC.) A. Gray, especially vegetatively, but differs in having thinner, less tomentose leaves, and smaller drooping heads arranged in naked terminal racemes, 2-3 heads to a node. Sierra Gamón is located at ca. 24° 36′ N, 104° 15′ W, ca. 30 km west of Yerbanis, Durango.

ACKNOWLEDGMENTS

I am grateful to Guy Nesom for the Latin diagnosis and to him and Jackie Soule for reviewing the manuscript.

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A NEW SPECIES OF *TRIDAX* (ASTERACEAE, HELIANTHEAE) FROM GYPSUM OUTCROPS IN NUEVO LEON, MEXICO

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ABSTRACT

A new species of *Tridax*, **T. hintoniorum** B. Turner, is described and illustrated from Nuevo León, México where it occurs on gypsum outcrops. It is most closely related to *T. candidissima* A. Gray, a gypseous endemic of San Luis Potosí, México.

KEY WORDS: *Tridax*, Asteraceae, Heliantheae, México

Routine identification of Mexican Asteraceae has revealed the following novelty.

Tridax hintoniorum B. Turner, *sp. nov.* TYPE: MEXICO. Nuevo León: Mpio. Galeana, between La Poza and Río de San José, 1450m, gypsum hillsides, 31 May 1992, *Hinton et al. 22031* (HOLOTYPE: TEX!; Isotype: MEXU!).

Tridace candidissima A. Gray similis sed foliis late oblanceolatis vel obovati-ellipticis (vs. linearibus) et capitulis in pedunculis nudis 10-40 cm long (vs. eradiatis in pedunculis brevibus plerumque 2-8 cm longis) differt.

Erect perennial herbs 30-85 cm high, stems loosely floccose with woolly hairs, among these are interspersed glandular trichomes, the latter uniseriate and up to 1.5 mm long. Leaves elliptic oblanceolate to ovate elliptic, sometimes oblanceolate, mostly 5-12 cm long, 1-4 cm wide, gradually reduced upwards, floccose-tomentose, trinervate; petioles narrowly winged and grading into the blades. Heads hemispheric, single on rather stout naked peduncles, the latter

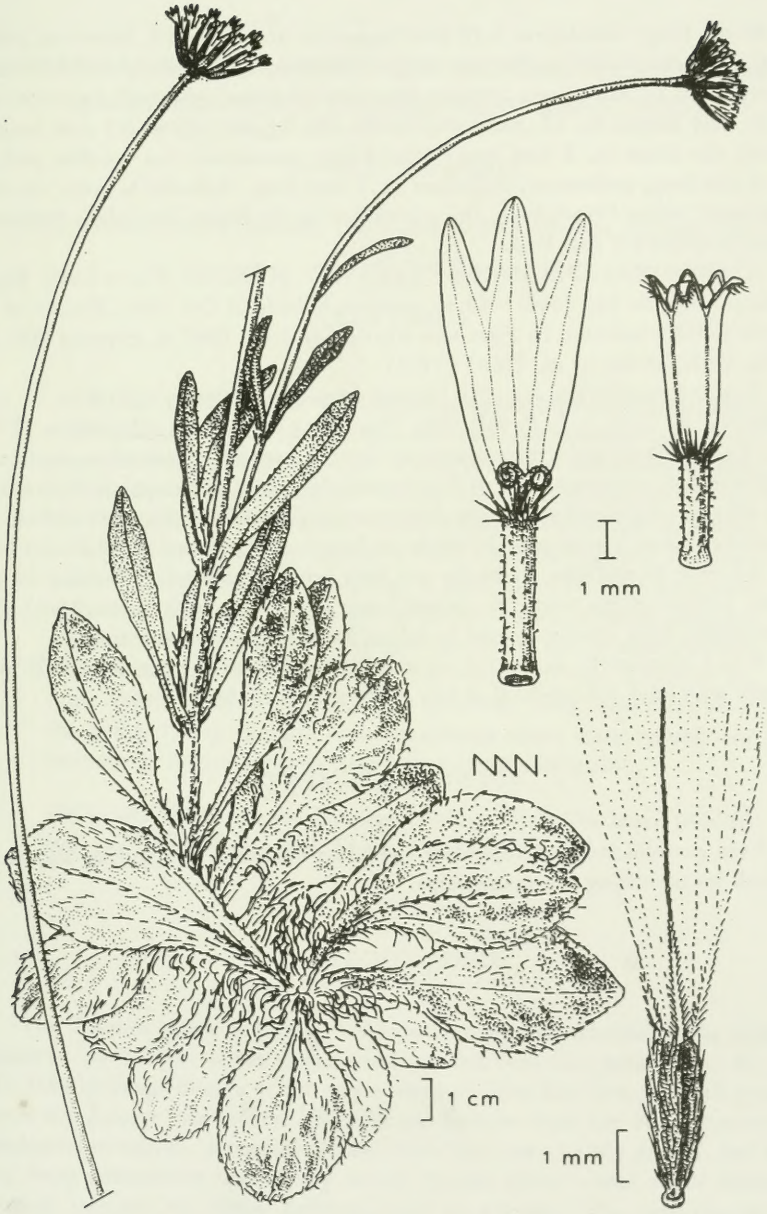

Fig. 1. Tridax hintoniorum, from holotype.

10-40 cm long. Involucres 8-12 mm high, the bracts ca. 13, biseriate, subequal, lanceolate-elliptic, floccose or pilose, interspersed with glandular hairs. Receptacles 4-6 mm across, convex, the pales scarious, persistent, lacerate apically. Ray florets ca. 13, pistillate, fertile, the ligules yellow, 5-7 mm long, 3 lobed, the lobes ca. 3 mm long. Disk florets numerous, the corollas yellow, ca. 8 mm long, pubescent, the tubes ca. 3 mm long. Achenes broadly clavate, appressed pilose throughout, the pappus of ca. 20 linear-lanceolate fimbriate tawny bristles 6-7 mm long.

ADDITIONAL SPECIMENS EXAMINED: MEXICO. Nuevo León: Mpio. Galeana, Río de San José, 1490 m, gypsum hillside, 2 Oct 1991, *Hinton et al. 21566* (TEX); between La Poza and Río de San José, 1840 m, gypsum hillside, 1 Jul 1992, *Hinton et al. 22061* (TEX).

Tridax hintoniorum is a very distinct species but clearly relates to *T. candidissima* A. Gray (*c.f.*, Powell 1965, Taxonomy of *Tridax* ... Brittonia 17:47-96). Both of these are strong perennials having floccose or tomentose vestiture, and both are monocephalous with nongraduate involucral bracts and have similar achenes and corollas. *Tridax hintoniorum* is readily distinguished from *T. candidissima* in having radiate heads on long naked peduncles (10-40 cm long vs. 2-8 cm); in addition its leaves are very broad and mostly confined to the lower portion of the stem (vs. leaves linear and stems leafy throughout). Interestingly, both species appear to be confined to gypsum outcrops.

It is a pleasure to name this remarkable species for the remarkable Hinton family who have collected all of the specimens available to date.

ACKNOWLEDGMENTS

I am grateful to Guy Nesom for the Latin diagnosis and to him and A.M. Powell for reviewing the manuscript.

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VASCULAR FLORA OF BUENOS AIRES NATIONAL WILDLIFE REFUGE (INCLUDING ARIVACA CIENEGA), PIMA COUNTY, ARIZONA

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ABSTRACT

Buenos Aires National Wildlife Refuge in southeastern Arizona spans a relatively narrow elevation range and does not encompass much topographic diversity, yet possesses a diverse flora of 566 native species. A biseasonal rainfall regime and the presence of many aquatic habitats contribute to the high diversity. Floristic analysis shows that the Refuge belongs in the Apachian District of the Madrean Floristic Province. Most of the vegetation on the Refuge is grassland, much of it dominated by introduced species. There are, however, remnant areas of grassland with a dense cover of native, perennial grasses. These grasslands occur at a surprisingly low elevation for this vegetation type, probably because of the relatively high rainfall in the Altar Valley. Also included in the Refuge is a unique low elevation ciénega where many aquatic and mesophytic species occur at their lowest elevational limits.

KEY WORDS: Arivaca Ciénega, Buenos Aires National Wildlife Refuge, Desert Grassland, Flora, Southeastern Arizona.

INTRODUCTION

The Buenos Aires National Wildlife Refuge was established in 1985 to preserve the habitat of the endangered masked bobwhite quail. Prior to 1985 all of the holdings were in active cattle ranches; there has been no cattle grazing since the Refuge was created. Within the Refuge there are desert grasslands composed of native, perennial species, that have been lightly grazed, and have not been extensively invaded by woody plants; there is also a low elevation ciénega (marshland) along Arivaca Creek at Arivaca. The objective of this

paper is to catalogue the flora of Buenos Aires National Wildlife Refuge and briefly describe its vegetation.

STUDY AREA

The Refuge is located 90 km southwest of Tucson and covers 45,540 ha (Fig. 1). It lies mostly in the Altar Valley east of the Baboquivari Mountains; elevation ranges from 925 m, where the Altar Wash leaves the Refuge along its northern boundary, to 1400 m in the low lying Las Guijas Mountains along the eastern boundary. Most of the area within the Refuge occurs within an elevation range of only 200 m from 950 to 1150 m. In July 1989 a 660-ha parcel at Arivaca Ciénega was purchased by the Nature Conservancy and transferred to the Refuge. Arivaca Ciénega lies about 5 km upstream (east) of the Refuge on Arivaca Creek at an elevation of 1110 m.

Climatic data for stations nearest the Refuge are shown in Table 1 (data from Sellers *et al.* 1985). Mean monthly temperatures reach maxima of 35° to 38° C in June and July and minima of 0° to 2° C in December and January. Winter minimum temperatures are probably low enough to exclude many Sonoran Desert species. Creosote bush (*Larrea tridentata* [DC.] Cov.), for example, has not been found within the Refuge. The distribution of rainfall is biseasonal with a distinct summer peak in July and August and a less marked winter peak from December to February. The driest months are May and June; this time of year, known as the arid foresummer in southeastern Arizona, is the season most unfavorable to plant growth and survival.

METHODS

I initiated this study in March 1988. I spent a total of 35 days in the field between March 1988 and April 1991. During this time I made approximately 920 plant collections which have been deposited in the University of Arizona Herbarium (ARIZ). While in the field, I made notes on vegetation and on the distributions of the few taxa that were not collected (Cactaceae, Agavaceae, and some common trees and shrubs). Floristic affinities were investigated by assigning all species into floristic elements as defined in McLaughlin (1992) following the procedures in McLaughlin & Bowers (1990).

FLORA

The total known flora of the Refuge consists of 93 families, 352 genera, 566 native species, 7 subspecific taxa, and 49 introduced species. The introduced

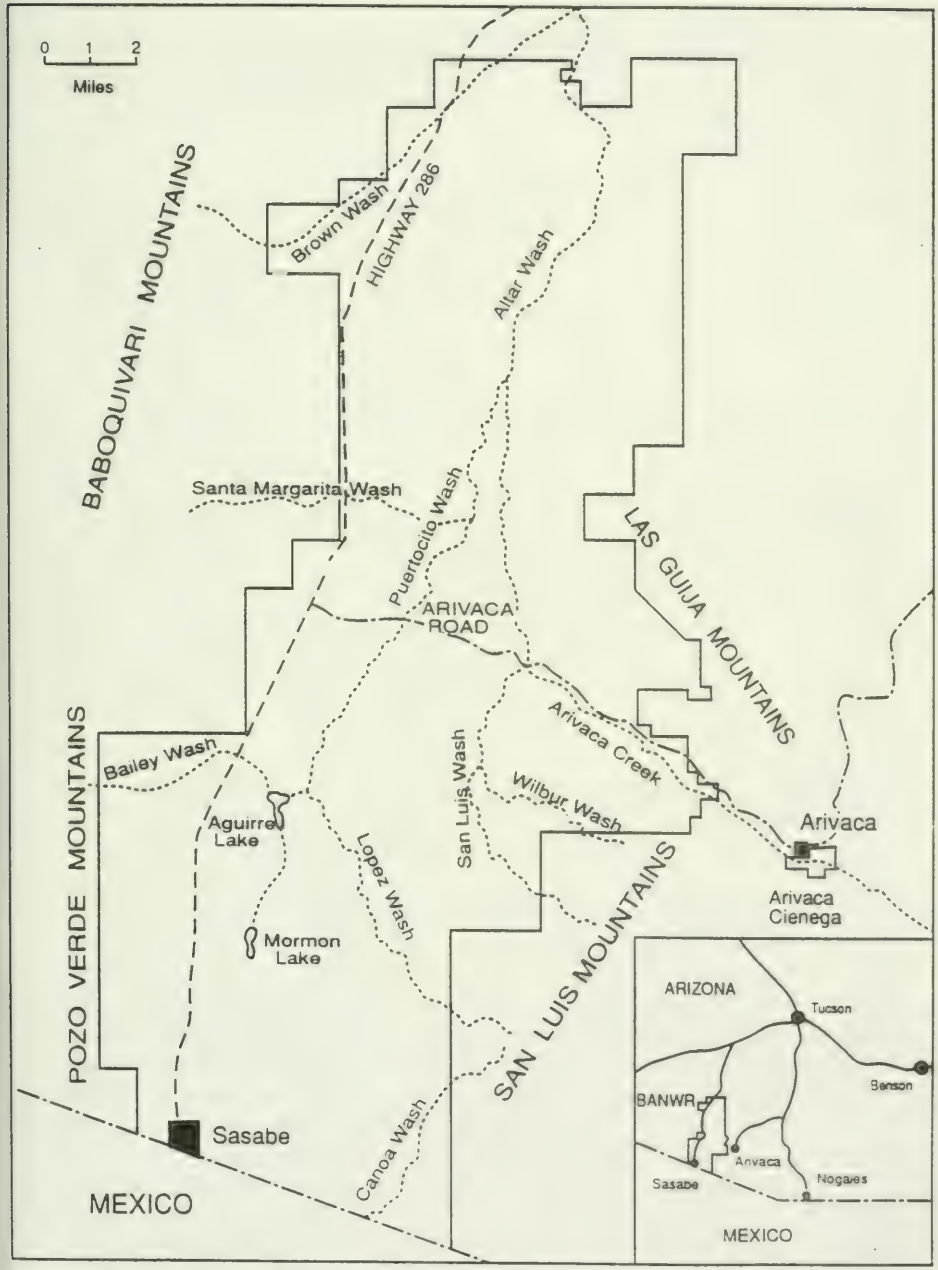

Fig. 1. Map of Buenos Aires National Wildlife Refuge, Pima County, Arizona.

TABLE 1. Climatic data from stations in the vicinity of Buenos Aires National Wildlife Refuge. Data are from Sellers *et al.* (1985); temperature in °C, precipitation in mm; temperature data are available only from the Anvil Ranch and Sasabe stations.

Station:	Anvil Ranch			Sasabe			Arivaca	Santa Margarita
Latitude:	31° 59′			31° 29′			31° 35′	31° 41′
Longitude:	111° 23′			111° 35′			111° 19′	111° 35′
Elevation:	840 m			1100 m			1120	1200 m
	Temperature			Temperature				
Month	Max.	Min.	Prec.	Max.	Min.	Prec.	Prec.	Prec.
January	19.1	0.4	19	17.2	1.7	32	24	26
February	21.1	1.5	15	19.1	2.8	30	22	34
March	23.5	3.8	18	20.8	4.3	25	24	23
April	28.1	6.8	7	25.2	7.2	7	6	9
May	32.7	11.0	5	29.3	10.3	4	4	4
June	38.3	16.6	7	34.7	16.1	6	11	11
July	38.0	21.1	66	35.1	19.2	89	107	97
August	36.7	19.9	57	33.5	18.3	75	88	94
September	35.5	16.2	36	32.1	15.8	46	45	49
October	30.6	9.8	19	27.8	10.5	24	30	12
November	23.8	3.6	13	21.6	5.4	25	23	24
December	19.7	0.4	25	17.6	2.2	48	39	27
Mean Annual	28.9	9.3	287	26.2	9.5	410	423	410

species account for 8% of the total, which is somewhat high for a flora of this size. Aquatic and wetland species account for approximately 13% of the flora.

The largest families in the flora are listed in Table 2. The composites (Asteraceae) and grasses (Poaceae) are by far the largest families with 96 and 88 species, respectively. The Poaceae also have the largest number of introduced species–18. Genera with five or more species in the flora are: *Chamaesyce* (spurges, 11 spp.), *Bouteloua* (grama grasses, 10 spp.), *Cyperus* (flat sedges, 9 spp.), *Opuntia* (chollas and prickly pears, 9 spp.), *Muhlenbergia* (muhly grasses, 7 spp.), *Aristida* (three-awn grasses, 6 spp.), *Boerhaavia* (spiderlings, 6 spp.), *Brickellia* (6 spp.), *Eragrostis* (lovegrasses, 6 spp.), *Eriogonum* (wild buckwheats, 6 spp.), *Ipomoea* (morning glories, 6 spp.), *Asclepias*

TABLE 2. Largest plant families in the flora of Buenos Aires National Wildlife Refuge.

Family	Number of Genera	Number of Native Species	Number of Introduced Species	Total Species
Asteraceae	56	94	2	96
Poaceae	41	70	18	88
Fabaceae	26	40	3	43
Euphorbiaceae	9	21	0	21
Cactaceae	6	18	0	18
Malvaceae	11	17	1	18
Cyperaceae	6	17	0	17
Brassicaceae	13	12	4	16
Boraginaceae	6	13	0	13
Solanaceae	6	13	0	13
Convolvulaceae	4	12	1	13
Polygonaceae	3	9	4	13
Onagraceae	5	12	0	12
Scrophulariaceae	8	10	1	11

(milkweeds, 5 spp.), *Astragalus* (milkvetches, locoweeds, 5 spp.), *Baccharis* (5 spp.), *Cryptantha* (5 spp.), *Lotus* (vetches, 5 spp.), *Oenothera* (evening primroses, 5 spp.), *Panicum* (panic grasses, 5 spp.), *Phacelia* (5 spp.), and *Polygonum* (knotweeds, 5 spp.).

The total number of native species (566) is rather high given the narrow elevational range (475 m), limited amount of field work, and relatively uniform vegetation. In a survey of local floras of Arizona, Bowers & McLaughlin (1982) found that areas with a large amount of elevational relief, oak woodland and aquatic habitats, and a long collecting history had the richest floras. Their model would predict a flora of just 240 species for the Refuge based on its elevational range and collecting history (3 years–the Refuge area was rarely collected prior to 1988).

Despite the low elevation range and lack of vegetational diversity, several ecological features at the Refuge contribute to its high species richness. One is the biseasonal distribution of rainfall. Winter rainfall and temperatures are high enough to support a significant winter annual flora of about 90 species. Many of these winter annuals are widespread in the Sonoran Desert, including several species of Asteraceae, Boraginaceae, Brassicaceae, Fabaceae,

Hydrophyllaceae, and Polemoniaceae. The majority of the herbaceous species, however, are phenologically active in the late summer and fall months following the summer rains.

Riparian areas have many species that are absent from or uncommon in the surrounding grasslands. Major riparian areas on the Refuge include Arivaca Creek, Brown Wash, San Luis Wash, Altar Wash, Puertocito Wash, Lopez Wash, and Canoa Wash (Fig. 1). The most common riparian tree is *Celtis reticulata* Torrey (hackberry); *Prosopis velutina* Wooton (mesquite), *Chilopsis linearis* (Cav.) Sweet (desert willow), and *Parkinsonia aculeata* L. (Mexican paloverde) are also common, especially in the lower elevation areas. Other species of trees and shrubs found mostly along watercourses include: *Aloysia gratissima* (Gill. & Hooker) Troncosa, *Brickellia californica* (Torrey & A. Gray) A. Gray, *Brickellia floribunda* A. Gray, *Fraxinus velutina* Torrey, *Juglans major* (Torrey) Heller, *Populus fremontii* S. Watson, *Quercus emoryi* Torrey, *Q. oblongifolia* Torrey, *Salix gooddingii* Ball, *Salix taxifolia* H.B.K., *Sapindus saponaria* L. var. *drummondii* (Hooker & Arn.) L. Benson, and *Vitis arizonica* Engelm. Many herbaceous species are more abundant in the shade of trees either in or along watercourses than in the adjacent grasslands, but few appear to be completely restricted to riparian sites. *Lythrum californicum* Torrey & A. Gray and *Oenothera rosea* Ait. are found only at Arivaca Ciénega and along Arivaca Creek; *Helenium thurberi* A. Gray occurs only along Arivaca Creek.

Several species in the flora are found only along Brown Wash in the northwestern corner of the Refuge. Many of these are relatively mesophytic species that are more common at higher elevations in the Baboquivari Mountains to the west; because of the drainage of moisture and cold air down Brown Canyon these species are able to extend their ranges into the Refuge at lower elevations. Species that have so far been found only in Brown Wash are: *Agastache wrightii* (Greenman) Wooton & Standley, *Cocculus diversifolius* DC., *Desmodium batocaulon* A. Gray, *Heterosperma pinnatum* Cav., *Hybanthus attenuatus* (Humb. & Bonpl.) G.K. Schulze, *Phacelia ramosissima* Douglas, *Sicyosperma gracile* A. Gray, *Sideroxylon lanuginosa* Michx., *Simmondsia chinensis* (Link) Schneid., *Sphaeralcea fendleri* A. Gray, *Thelypodiopsis linearifolia* (A. Gray) Al-Shehbaz, and *Tithonia thurberi* A. Gray.

The presence of aquatic habitats can greatly increase the plant diversity of an area (Bowers & McLaughlin 1982). On the Refuge, stock tanks and reservoirs support species not found in the grasslands or riparian (wash) areas. Relatively few strict aquatics (submerged, floating, and emergent plants) occur in the many impoundments found on the Refuge, possibly because these small bodies of water dry up frequently. Aquatics that have been found in tanks and reservoirs are: *Heteranthera limosa* (Swartz) Willd., *Lemna minima* H.B.K., *Marsilea vestita* Hooker & Grev., *Polygonum pensylvanicum* L., *Potamogeton foliosus* Raf., *Potamogeton pusillus* L., and *Scirpus californicus* (C.

Mey.) Steud. Aquatic plants have excellent mechanisms for dispersal; it seems likely that additional species will be found in areas such as Aguirre Lake and Mormon Lake if they are periodically monitored.

Several species, which appear to depend on periodic desiccation of the lakes and tanks, are found almost exclusively along lake margins and dry bottoms, a habitat similar to the well known "vernal pools" of cismontane California. Species occurring exclusively or predominantly in this habitat include: *Alopecurus carolinianus* Walt., *Astragalus nuttallianus* DC. var. *cedroensis* Jones, *Eryngium heterophyllum* Engelm., *Hordeum pusillum* Nutt., *Lobelia fenestralis* Cav., *Myosurus minimus* L., *Oenothera flava* (A. Nelson) Garrett, *Potentilla rivalis* Nutt., *Verbena bracteata* Lag. & Rodr., and *Veronica peregrina* L. ssp. *xalapensis* (H.B.K.) Pennell.

The vegetation map of Brown & Lowe (1977) shows the entire area occupied by Buenos Aires National Wildlife Refuge as being desert grassland. This vegetation type varies considerably in its physiognomy and species composition, however, depending on land use, soil depth, and slope aspect and angle. Most of the grasslands on the Refuge occur on relatively deep alluvial soils in the valley bottom. Although rocky, upland sites are not extensive on the Refuge, these sites do support a community with increased diversity of lifeforms and species. Species restricted to such upland grasslands include: *Agave parviflora* Torrey, *Anthericum torreyi* Baker, *Bouteloua eludens* Griffiths, *Cheilanthes* spp., *Coreocarpus arizonicus* (A. Gray) Blake, *Digitaria insularis* (L.) Mez, *Dryopetalon runcinatum* A. Gray, *Ericameria laricifolia* (A. Gray) Shinners, *Erigeron neomexicanus* A. Gray, *Erythrina flabelliformis* Kearney, *Eysenhardtia polystachya* (Ortega) Sarg., *Galactia wrightii* A. Gray, *Herissantia crispa* (L.) Briz., *Heteropogon melanocarpus* (Ell.) Bentham, *Mammillaria heyderi* Muehl., *Notholaena* spp., *Passiflora foetida* L., *Pellaea truncata* Goodding, *Phaseolus heterophyllus* Willd., *Schizachyrium cirratum* (Hack.) Wooton & Standley, *Tecoma stans* (L.) H.B.K., and *Trachypogon secundus* (Presl) Scribn.

Several species have so far been found in the Refuge only on the western and southern slopes of the Las Guijas Mountains. These include: *Aloysia wrightii* (A. Gray) Heller, *Cynanchum arizonicum* (A. Gray) Shinners, *Eupatorium solidaginifolium* A. Gray, *Haplophyton crooksii* L. Benson, *Iresine heterophylla* Standley, *Plumbago scandens* L., *Quercus turbinella* E. Greene, *Senecio lemmoni* A. Gray, and *Waltheria americana* L. Since neither the Las Guijas nor the San Luis Mountains have been thoroughly explored, additions to the flora are likely to be found in these areas.

A few mesophytic species that are usually found in Arizona at much higher elevations (often in pine forests) occur on the Refuge in grasslands but are very rare. Three such species co-occur just a few miles southeast of Refuge headquarters: *Eryngium heterophyllum*, *Heterotheca rutteri* (Rothrock) Shinners, and *Aster falcatus* Lindl. ssp. *commutatus* (Torrey & A. Gray) A.G. Jones–the latter is also found at Arivaca Ciénega. Two other higher elevation grassland

species, *Berlandiera lyrata* Bentham and *Cirsium ochrocentrum* A. Gray, are also restricted to a small area south of Refuge Headquarters.

VEGETATION

The dominant vegetation on the Refuge is grassland. There is no oak woodland, although three species of oaks do occur in the flora: *Quercus emoryi* (Emory oak) and *Q. oblongifolia* (Mexican blue oak) are found only along a few watercourses in the southeast part of the Refuge, and *Q. turbinella* (scrub oak) is scattered in the Las Guijas Mountains.

The grassland vegetation in the valley bottom varies in aspect and species composition across the Refuge. Areas mapped as grasslands just to the north of the Refuge on private and state owned lands are dominated by *Prosopis velutina*, *Isocoma tenuisecta* E. Greene (burroweed), and *Opuntia* species; perennial grasses here essentially have been eliminated by overgrazing. Regrettably, much of the grassland in the Altar Valley and elsewhere in southeastern Arizona is in this poor condition. Within the Refuge, the grasslands on the northern, central, and western portions have a lush aspect but are dominated by a single species, the exotic perennial, *Eragrostis lehmanniana* Nees (Lehmann lovegrass). *Prosopis velutina*, *Opuntia* spp., *Acacia greggii* A. Gray (catclaw acacia), *Mimosa biuncifera* Bentham (wait-a-bit), and other woody plants are often abundant. Another introduced species, *Sorghum halepense* (L.) Pers. (Johnson grass), dominates the floodplains along the major washes.

Along the eastern edge of the Refuge, up to the base of the Las Guijas and San Luis Mountains, where elevations are higher, slopes are steeper and rockier, and soils are more variable (including many calcareous sites), the grasslands are less disturbed and more diverse. The grassland southeast of Refuge Headquarters is dominated by several native perennials, including *Aristida ternipes* Cav., *Bouteloua curtipendula* (Michx.) Torrey, *B. hirsuta* Lag., *B. repens* (H.B.K.) Scribn. & Merr., *Bothriochloa barbinodis* (Lag.) Herter, *Digitaria californica* (Bentham) Henr., *Eragrostis intermedia* A.S. Hitchc., and *Leptochloa dubia* (H.B.K.) Nees. Also present are many native perennial herbs, *Fouquieria splendens* Engelm. (ocotillo), large and small cacti, and several Agavaceae [*Agave palmeri* Engelm., *Dasylirion wheeleri* S. Watson (sotol), *Nolina microcarpa* S. Watson, and *Yucca elata* Engelm. (beargrass)]. On low ridge tops in this area the grass cover is dominated by *Aristida purpurea* Nutt. var. *longiseta* (Steud.) Vasey, *Bouteloua chondrosioides* (H.B.K.) Bentham *ex* S. Watson, *B. eriopoda* (Torrey) Torrey, *B. hirsuta*, and *Heteropogon contortus* (L.) P. Beauv. *ex* Roemer & Schultes; associated with these grasses are several low shrubs including *Calliandra eriophylla* Bentham, *Krameria parvifolia* Bentham, and *Zinnia acerosa* (DC.) A. Gray.

TABLE 3. Precipitation in major valleys in southeastern Arizona. Elevations (in meters) and precipitation (in mm) are from weather stations given in Sellers *et al.* (1985).

Altar		Santa Cruz		San Pedro		Sulphur Springs		San Simon	
Elev.	Prec.	Elev.	Prec.	Elev.	Prec.	Elev.	Prec.	Elev.	Prec.
		460	226						
		573	244	632	340				
		692	282	646	373				
840	287	820	272						
		945	330	957	340			884	218
		981	348						
		996	368	1085	335			1113	198
1094	424			1094	290			1100	229
				1125	320			1149	254
1196	411	1161	399	1173	295	1231	340		
						1273	292		
				1387	325	1347	297		
		1445	429	1405	338	1485	323		

These desert grassland communities are occurring at a very low elevation (1100 m) in Arizona for this vegetation type. Shreve (1951) states that true grasslands in Arizona are not found below 3500 feet (1067 m). The upper Altar Valley can support this native, perennial grassland at such a low elevation because it receives relatively high rainfall, comparable to that of other valleys in southeastern Arizona at higher elevations. In this part of the state there is a gradient of decreasing rainfall in going from west to east (Table 3). At 1200 m elevation the Altar and Santa Cruz Valleys receive about 400 mm of precipitation annually; rainfall at comparable elevations going eastward is about 300 mm in the San Pedro and Sulphur Springs Valleys and about 250 mm in the San Simon Valley.

Most desert grasslands of the Southwest have been dramatically degraded by overgrazing and the introduction of exotic plant species. The extensive monospecific stands of Lehmann lovegrass that dominate the central portions of the Refuge probably developed no more than 20-30 years ago. This species was first introduced into southern Arizona in 1932 by the Soil Conservation Service (Freeman 1979); this exotic grass now infests over 200,000 ha of formerly native grassland (Cox & Ruyle 1986).

The spread of Lehmann lovegrass on the Refuge was probably facilitated

by grazing, since this exotic is less palatable than the native perennial grasses it has replaced (Cable 1971; Freeman 1979). The nearly monospecific stands of this species are not good habitat for the masked bobwhite, which requires more diverse grass-herb vegetation (Goodwin & Hungerford 1977) with legumes to provide seed and cover during the winter. Lehmann lovegrass stands have low diversity of native grasses, herbs, shrubs, grasshoppers, rodents, and birds, in comparison to stands of native perennial grasses (Bock *et al.* 1986).

There are no records of what the grasslands looked like on the lower elevations at the Refuge prior to the introduction of Lehmann lovegrass. Haskell (1945) described a lightly grazed grassland at similar elevations (1130 m) on the Page Ranch on the northwest side of the Santa Catalina Mountains. This grassland was dominated by *Aristida hamulosa* Henr., *A. purpurea* var. *longiseta*, *Bouteloua rothrockii* Vasey, *B. curtipendula*, *B. eriopoda*, and *Hilaria belangeri* (Steud.) Nash. Brown (1982) suggests that the grasslands of the Altar Valley, prior to overgrazing and invasion of exotics, were similar to the Sonoran savanna grassland communities of the Plains of Sonora (one of Forrest Shreve's geographic subdivisions of the Sonoran Desert), which were dominated by *Bouteloua rothrockii*, several species of three-awn (*Aristida californica* Thurber, *A. hamulosa*, *A. ternipes*, *A. wrightii* Nash), other grama grasses (*Bouteloua aristidoides* [H.B.K.] Griseb., *B. parryi* [Fourn.] Griffiths, *B. radicosa* [Fourn.] Griffiths, *B. repens*), *Chloris* spp., and *Heteropogon contortus*.

Today Rothrock grama (*Bouteloua rothrockii*), poverty three-awn (*Aristida hamulosa*), spidergrass (*A. ternipes*), Arizona cottontop (*Digitaria californica*), and slender grama (*Bouteloua repens*) are most common along roadsides and in patches not dominated by Lehmann lovegrass. Spiderlings (*Boerhaavia* spp.), spurges (*Chamaesyce* spp.), purslanes (*Portulaca* spp.), globe amaranths (*Gomphrena* spp.), and *Gaura* spp. are the commonest herbs. All these species were doubtless more abundant prior to the introduction of Lehmann lovegrass. Within the Lehmann lovegrass dominated areas there are occasional patches of curly mesquite grass (*Hilaria belangeri*); these patches have several characteristic herbs including *Allium macropetalum* Rydb. and *Lupinus brevicaulis* S. Watson.

ARIVACA CIENEGA

The term "ciénegas" is used in the Southwest for midelevation wetlands with saturated, organic, reducing soils (Hendrickson & Minckley 1984). These wetlands were once much more abundant in the Southwest. They have been severely altered and diminished in areal extent by grazing, introduction of exotic plants, and downstream arroyo cutting. Arivaca Ciénega is one of the better preserved ciénega wetland communities in southeastern Arizona, and

it is also the most xeric, occurring further west and at a lower elevation than other remaining ciénegas in the region.

Hendrickson & Minckley (1984) suggested that a relatively impermeable dike of shales, sandstone, conglomerate, and limestone outcropping below Arivaca has forced groundwater up to the surface, creating permanent surface flow and marshlands. They stated that the current meadow area south of Arivaca (now incorporated into the Refuge) is a remnant of a once more extensive ciénega system. The wetlands are now maintained by a concrete ford across Arivaca Creek which acts as a check dam to prevent upstream arroyo cutting.

The vegetation at Arivaca Ciénega can be divided into four communities or zones. Along the periphery there is a mesquite zone with *Isocoma tenuisecta* (burroweed), *Gutierrezia microcephala* (DC.) A. Gray (snakeweed), *Acacia greggii*, *Zizyphus obtusifolia* (Hooker) A. Gray (gray thorn), and other spiny shrubs. This area was badly overgrazed prior to being added to the Refuge; most native perennial grasses and palatable forbs have been completely eliminated.

Inside the mesquite zone is a zone of *Sporobolus wrightii* Munro *ex* Scribn. (sacaton), best developed on the northern end of the ciénega. This too has been heavily grazed but has withstood the stress of cattle much better than has the mesquite zone. Many forbs that are most abundant in the meadow zone extend sporadically into the sacaton zone.

The meadow zone, the third community type, is a sward of grasses, sedges, and forbs that is wet in the spring and in the late summer following the summer rains. It differs from less heavily grazed southeastern Arizona ciénegas in having a high cover of weedy forbs and grasses: *Ambrosia confertiflora* DC. and *A. psilostachya* DC. (ragweeds), *Xanthium strumarium* L. (cocklebur), *Poa annua* L., and *Polypogon monspeliensis* (L.) Desf. (rabbitfoot grass). Nevertheless, numerous native ciénega species not found elsewhere on the Refuge have persisted in the meadow zone; many of these are high elevation plants reaching their lower limits at Arivaca Ciénega: *Agropyron trachycaulum* (Link) Malte, *Ambrosia trifida* L., *Bothriochloa saccharoides* (Swartz.) Rydb., *Carex chihuahensis* Mack., *Chamaesyce vermiculata* (Raf.) House, *Juncus balticus* Willd., *J. torreyi* Cov., *Muhlenbergia asperifolia* (Nees & Mey.) Parodi, *Nothoscordum texanum* Jones, *Oenothera speciosa* Nutt., *Pyrrhopappus rothrockii* A. Gray, *Ranunculus macranthus* Scheele, *Setaria geniculata* (Lam.) Beauv., *Sidalcea neomexicana* A. Gray, *Sisyrinchium demissum* E. Greene, and *Trifolium wormskioldii* Lehm.

Many of the native perennials that are dominant in the meadow now (e.g., *Bidens aurea* [Ait.] Sherff and *Ranunculus macranthus*) probably increased as a result of grazing. Cover of grasses and sedges is likely to increase in the meadow zone as the area recovers from grazing.

The innermost zone of the ciénega consists of springs and permanently wet ground. Along many of the springs there are stands of *Salix gooddingii*

(willow) with occasional *Populus fremontii* (cottonwood). These springs support numerous species of wetland and aquatic plants not found elsewhere on the Refuge: *Azolla mexicana* Presl, *Berula erecta* (Huds.) Cov., *Bidens laevis* (L.) BSP., *Ceratophyllum demersum* L., *Cyperus odoratus* L., *Eleocharis bella* (Piper) Svenson, *Hydrocotyle ranunculoides* L. f., *Leersia oryzoides* (L.) Swartz., *Lemna gibba* L., *L. minor* L., *Myriophyllum exalbescens* Fern., *Paspalum distichum* L., *Polygonum punctatum* Ell., *Ranunculus hydrocharoides* A. Gray, *Scirpus olneyi* A. Gray, *Typha latifolia* L., and *Zannichellia palustris* L.

FLORISTIC AFFINITIES

I have divided the western United States into three sets of floristic areas–5 floristic provinces for widespread species, 9 floristic subprovinces for species of intermediate range, and 20 floristic districts for narrowly distributed species (McLaughlin 1992). Widespread species were defined as those occurring in >20% of a set of 101 local floras covering the entire western U.S.A. west of the Great Plains; narrow species were defined as those occurring in <10% of these local floras. Associated with each floristic area is a floristic element–a group of species with more or less coincident ranges centered on the floristic area. Table 4 presents a summary of the floristic affinities of the flora of Buenos Aires National Wildlife Refuge, listing the numbers and percentages of species associated with the various floristic elements.

The Refuge lies near the boundary of the Sonoran Floristic Province to the south, west, and north, and the Madrean Floristic Province to the east. Desert species are common, especially at the north end of the Refuge and among the winter annuals. Nevertheless, the species of Madrean and Apachian affinities clearly dominate in the flora, placing the Refuge in the Apachian District of the Madrean Province.

Among widespread species, all 5 floristic elements are represented. The Madrean element is best represented (7.1% of the total flora), followed by the Sonoran (5.8%) and Californian (2.7%) elements. Among species with intermediate size ranges, the Madrean (20.1%), Sonoran (7.6%), and Californian (4.6%) elements are most important. The Apachian element (27.6%) accounts for more than half of the species with narrow ranges; Arizona Upland Desert (9.0%) and Chihuahuan Desert (5.3%) elements are also well represented.

The techniques used here to classify species into floristic elements work best for species with more or less continuous ranges; *i.e.*, most terrestrial species of upland, nonweedy habitats. Aquatic and wetland species often have wide, discontinuous ranges. Among the sample of 101 local floras from the western United States used to develop the floristic classification, aquatic habitats are well represented only in those floras from the California Floristic Province. Widespread and intermediate aquatic and wetland plants thus tend to be

TABLE 4. Floristic affinities of the flora of Buenos Aires National Wildlife Refuge.

Distribution Category	Floristic Element	No. Species	%
Widespread Species:	Madrean element	39	7.1
	Sonoran element	33	5.8
	Californian element	15	2.7
	Intermountain element	13	2.3
	Cordilleran element	8	1.6
Intermediate Species:	Madrean element	113	20.1
	Sonoran element	44	7.6
	Californian element	26	4.6
	Other elements	7	1.2
Narrow Species:	Apachian element	154	27.6
	Arizona Upland Desert element	51	9.0
	Chihuahuan Desert element	29	5.3
	Peninsular California element	11	1.9
	Other elements	18	3.2

grouped into the Californian elements and narrowly distributed wetland plants tend to be placed in the Peninsular (southern) California element.

THREATENED AND ENDANGERED SPECIES

Thus far, few plants have been discovered in the Refuge that are on Federal Threatened or Endangered Species lists or are candidates for these lists. *Coryphantha scheeri* (Kuntze) L. Benson var. *robustispina* (Schott) L. Benson (Pima pineapple cactus) is proposed endangered (Rutman 1992). Steve Dobrott, wildlife biologist at the Refuge, has found 21 individuals south of the Refuge headquarters on reddish adobe soil. *Agave parviflora* (small flowered agave) is a Category 2 species (Rutman 1992). It is widespread but rather uncommon on the Refuge, occurring occasionally on rocky hilltops in the southeastern portion of the Refuge north of the Las Guijas Mountains. *Heterotheca rutteri* is a Category 2 species known on the Refuge from a single population in desert grassland south of the Headquarters. *Amsonia grandiflora* Alexander (Category 2), *Coryphantha recurvata* (Engelm.) Britton & Rose (Category 1),

Cynanchum wigginsii Shinners (Category 2), and *Phaseolus supinus* Wiggins & Rollins (Category 2) are known from sites adjacent to the Refuge.

CHECKLIST

The following checklist includes all vascular plants known to occur on Buenos Aires National Wildlife Refuge. Nomenclature in the following checklist follows Lehr (1978) and the supplements to that work (Lehr & Pinkava 1980, 1982), except for the Euphorbiaceae, which follows Kartesz & Kartesz (1980), and where otherwise noted. Taxa preceded by an asterisk (*) are introduced exotics.

Pteridophyta

ADIANTACEAE–*Cheilanthes lindheimeri* Hooker; *C. wootoni* Maxon; *C. wrightii* Hooker; *Notholaena grayi* Davenp.; *N. integerrima* Hooker; *N. sinuata* (Lag.) Kaulf.; *N. standleyi* Maxon; *Pellaea truncata* Goodding.

AZOLLACEAE–*Azolla mexicana* Presl.

MARSILEACEAE–*Marsilea vestita* Hooker & Grev.

Gymnospermae

EPHEDRACEAE–*Ephedra trifurca* Torrey.

Dicotyledonae

ACANTHACEAE–*Anisacanathus thurberi* (Torrey) A. Gray; *Carlowrightia arizonica* A. Gray; *Siphonoglossa longiflora* (Torrey) A. Gray; *Tetramerium nervosum* Nees [*T. hispidum* Nees].

AIZOACEAE–**Glinus radiatus* (Ruiz & Pavón) Rohrb.; **Mollugo verticillata* L.; *Trianthema portulacastrum* L.

AMARANTHACEAE–**Amaranthus albus* L.; *A. palmeri* S. Watson; *A. torreyi* (A. Gray) Bentham; *Froelichia arizonica* Thornber; *Gomphrena caespitosa* Torrey; *G. sonorae* Torrey; *Guilleminea densa* (Willd.) Moq.; *Iresine heterophylla* Standley; *Tidestromia lanuginosa* (Nutt.) Standley.

APIACEAE–*Berula erecta* (Huds). Cov.; *Bowlesia incana* Ruiz & Pavón; *Daucus pusillus* Michx.; *Eryngium heterophyllum* Engelm.; *Hydrocotyle ranunculoides* L. f.; *Lomatium nevadense* (S. Watson) Coult. & Rose var. *pseudorientale* (Jones) Munz; *Spermolepis echinata* (Nutt.) Heller; *Yabea microcarpa* (Hooker & Arn.) K.-Pol.

APOCYNACEAE–*Haplophyton crooksii* L. Benson; *Macrosiphon brachysiphon* (Torrey) A. Gray.

ARISTOLOCHIACEAE–*Aristolochia watsoni* Wooton & Standley.

ASCLEPIADACEAE–*Asclepias asperula* (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson; *A. brachystephana* Engelm.; *A. involucrata* Engelm.; *A. nyctaginifolia* A. Gray; *A. subverticillata* (A. Gray) Vail; *Cynanchum arizonicum* (A. Gray) Shinners; *Sarcostemma crispum* Bentham; *S. cynanchoides* Decne. ssp. *cynanchoides*; *S. cynanchoides* Decne. ssp. *hartwegii* (Vail) R. Holm.

ASTERACEAE–*Acourtia nana* (A. Gray) Reveal & King; *A. thurberi* (A. Gray) Reveal & King; *A. wrightii* (A. Gray) Reveal & King; *Ambrosia confertiflora* DC.; *A. psilostachya* DC.; *A. trifida* L. [*A. aptera* DC.]; *Artemisia ludoviciana* Nutt.; *Aster falcatus* Lindl. ssp. *commutatus* (Torrey & A. Gray) A.G. Jones; *A. subulatus* Michx. var. *ligulatus* Shinners; *Baccharis brachyphylla* A. Gray; *B. glutinosa* Pers.; *B. pteronioides* DC.; *B. sarothroides* A. Gray; *B. thesioides* H.B.K.; *Bahia absinthifolia* Bentham var. *dealbata* A. Gray; *Baileya multiradiata* Harvey & A. Gray; *Berlandiera lyrata* Bentham var. *macrophylla* A. Gray; *Bidens aurea* (Ait.) Sherff; *B. bigelovii* A. Gray; *B. ferulaefolia* (Jacq.) DC.; *B. laevis* (L.) BSP.; *B. leptocephala* Sherff; *Brickellia baccharidea* A. Gray; *B. californica* (Torrey & A. Gray) A. Gray; *B. chlorolepis* (Wooton & Standley) Shinners; *B. coulteri* A. Gray; *B. floribunda* A. Gray; *B. venosa* (Wooton & Standley) Robins.; *Calycoseris wrightii* A. Gray; *Carminatia tenuiflora* DC.; *Chaenactis stevioides* Hooker & Arn.; *Cirsium neomexicanum* A. Gray; *C. ochrocentrum* A. Gray; *Conyza canadensis* (L.) Cronq.; *C. coulteri* A. Gray; *Coreocarpus arizonicus* (A. Gray) Blake; *Dyssodia pentachaeta* (DC.) Robins.; *Encelia farinosa* A. Gray; *Ericameria laricifolia* (A. Gray) Shinners; *Erigeron divergens* Torrey & A. Gray; *E. neomexicanus* A. Gray; *Eriophyllum lanosum* A. Gray; *Eupatorium pycnocephalum* Less.; *E. solidaginifolium* A. Gray; *Evax multicaulis* DC.; *Filago californica* Nutt.; *F. depressa* A. Gray; *Gnaphalium chilense* Spreng.; *G. leucocephalum* A. Gray; *G. purpureum* L.; *G. wrightii* A. Gray; *Gutierrezia microcephala* (DC.) A. Gray; *G. sarothrae* (Pursh) Britton & Rusby; *Helenium thurberi* A. Gray; *Helianthus annuus* L.; *H. petiolaris* Nutt.; *Heterosperma pinnatum* Cav.; *Heterotheca rutteri* (Rothrock) Shinners; *H. subaxillaris* (Lam.) Britton & Rusby; *Hymenoclea monogyra* Torrey & A. Gray; *Hymenothrix wislizenii* A. Gray; *Isocoma tenuisecta* E. Greene; **Lactuca serriola* L.; *Lagascea decipiens* Hemsley; *Lasthenia chrysostoma* (Fischer & Meyer) E. Greene; *Leucelene ericoides* (Torrey) E. Greene; *Machaeranthera gracilis* (Nutt.) Shinners; *M. pinnatifida* (Hooker) Shinners ssp. *pinnatifida*; *M. tagetina* E.

Greene; *M. tephrodes* (A. Gray) E. Greene; *Malacothrix californica* DC. var. *glabrata* Eaton; *M. clevelandii* A. Gray; *M. fendleri* A. Gray; *M. sonchoides* (Nutt.) Torrey & A. Gray; *Melampodium longicorne* A. Gray; *Microseris linearifolia* (DC.) Schultz-Bip.; *Parthenice mollis* A. Gray; *Pectis longipes* A. Gray; *Porophyllum gracile* Bentham; *P. ruderale* (Jacq.) Cass. ssp. *macrocephalum* (DC.) R.R. Johnson; *Pyrrhopappus rothrockii* A. Gray [*P. multicaulis* DC.]; *Rafinesquia californica* Nutt.; *R. neomexicana* A. Gray; *Senecio douglasii* DC. var. *douglasii*; *S. douglasii* DC. var. *longilobus* (Bentham) L. Benson; *S. lemmoni* A. Gray; *Solidago sparsiflora* A. Gray; **Sonchus asper* (L.) Hill; *Stephanomeria exigua* Nutt.; *S. pauciflora* (Torrey) A. Nelson; *Tithonia thurberi* A. Gray; *Trixis californica* Kellogg; *Verbesina encelioides* (Cav.) Bentham & Hooker; *Viguiera dentata* (Cav.) Spreng. var. *lancifolia* Blake; *V. multiflora* (Nutt.) Blake; *Xanthium strumarium* L.; *Zinnia acerosa* (DC.) A. Gray.

BERBERIDACEAE–*Berberis haematocarpa* Wooton.

BIGNONIACEAE–*Chilopsis linearis* (Cav.) Sweet; *Tecoma stans* (L.) H.B.K.

BORAGINACEAE–*Amsinckia intermedia* Fischer & Meyer; *Cryptantha angustifolia* (Torrey) E. Greene; *C. barbigera* (A. Gray) E. Greene; *C. micrantha* (Torrey) I.M. Johnston; *C. nevadensis* A. Nelson & Kenn.; *C. pterocarya* (Torrey) E. Greene; *Harpagonella palmeri* A. Gray var. *arizonica* I.M. Johnston; *Lappula redowskii* (Hornem.) E. Greene; *Pectocarya heterocarpa* I.M. Johnston; *P. platycarpa* Munz & I.M. Johnston; *P. recurvata* I.M. Johnston; *Plagiobothrys arizonicus* (A. Gray) E. Greene; *P. pringlei* E. Greene.

BRASSICACEAE–*Arabis perennans* S.Watson; **Capsella bursa-pastoris* (L.) Medic.; *Caulanthus lasiophyllus* (Hooker & Arn.) Payson; *Descurainia pinnata* (Walt.) Britton ssp. *halictorum* (Cockl.) Detl.; **D. sophia* (L.) Webb; *Draba cuneifolia* Nutt. var. *integrifolia* S. Watson; *Dryopetalon runcinatum* A. Gray; *Erysimum capitatum* (Douglas) E. Greene; *Lepidium lasiocarpum* Nutt. var. *lasiocarpum*; *L. thurberi* Wooton; *L. virginicum* L. var. *medium* (E. Greene) C.L. Hitchc.; *Lesquerella gordoni* (A. Gray) S. Watson; **Nasturtium officinale* R. Br.; **Sisymbrium irio* L.; *Thelypodiopsis linearifolia* (A. Gray) Al-Shehbaz; *Thysanocarpus curvipes* Hooker var. *elegans* (Fischer & Mey.) Robins.

CACTACEAE–*Carnegiea gigantea* (Engelm.) Britton & Rose; *Coryphantha scheeri* (Kuntze) L. Benson var. *robustispina* (Schott) L. Benson; *C. vivipara* (Nutt.) Britton & Rose var. *bisbeeana* (Orcutt) L. Benson; *Echinocereus fasciculatus* (Engelm.) L. Benson var. *fasciculatus*; *E. fendleri* (Engelm.) Rumpler; *E. pectinatus* (Scheidw.) Engelm. var.

rigidissimus (Engelm.) Engelm.; *Ferocactus wislizenii* (Engelm.) Britton & Rose; *Mammillaria heyderi* Muehl. var. *heyderi* [*M. gummifera* Engelm. var. *applanata* (Engelm.) L. Benson]; *M. macdougalii* Rose [*M. gummifera* Engelm. var. *macdougalii* (Rose) L. Benson]; *M. microcarpa* Engelm.; *Opuntia arbuscula* Engelm.; *O. engelmannii* Salm-Dyck [*O. phaeacantha* Engelm. var. *discata* (Griffiths) L. Benson & Walkington]; *O. fulgida* Engelm. var. *mammillata* (Schott) Coulter; *O. leptocaulis* DC.; *O. macrorhiza* Engelm. var. *macrorhiza*; *O. phaeacantha* Engelm. var. *major* Engelm.; *O. spinosior* (Engelm. & Bigelow) Toumey; *O. versicolor* Engelm.; *O. violacea* Engelm. var. *santa-rita* (Griffiths & Hare) L. Benson.

CAMPANULACEAE–*Lobelia fenestralis* Cav.; *Triodanis biflora* (Ruiz & Pavón) E. Greene; *T. holzingeri* McVaugh.

CAPPARIDACEAE–*Polanisia dodecandra* (L.) DC. ssp. *trachysperma* (Torrey & A. Gray) Iltis.

CAPRIFOLIACEAE–*Sambucus mexicana* Presl.

CARYOPHYLLACEAE–*Loeflingia squarrosa* Nutt.; *Silene antirrhina* L.

CERATOPHYLLACEAE–*Ceratophyllum demersum* L.

CHENOPODIACEAE–*Atriplex canescens* (Pursh) Nutt.; *A. elegans* (Moq.) D. Dietr. ssp. *elegans*; *Chenopodium berlandieri* Moq. var. *sinuata* (Murr.) Wahl; *C. desiccatum* A. Nelson var. *leptophylloides* (Murr.) Wahl; *C. incanum* (S. Watson) Heller; *Monolepis nuttalliana* (Schult.) E. Greene; **Salsola iberica* Sennen & Pau.

COCHLOSPERMACEAE–*Amoreuxia palmatifida* Moç. & Sessé.

CONVOLVULACEAE–**Convolvulus arvensis* L.; *C. equitans* Bentham; *Cuscuta erosa* Yuncker; *Evolvulus alsinoides* L.; *E. arizonicus* A. Gray; *E. pilosus* Nutt.; *E. sericeus* Swartz; *Ipomoea barbatisepala* A. Gray; *I. coccinea* L.; *I. costellata* Torrey; *I. hederacea* (L.) Jacq.; *I. leptotoma* Torrey; *I. purpurea* (L.) Rothrock.

CRASSULACEAE–*Crassula erecta* (Hooker & Arn.) Berger [*Tillaea erecta* Hooker & Arn.]

CUCURBITACEAE–*Apodanthera undulata* A. Gray; *Cucurbita digitata* A. Gray; *C. foetidissima* H.B.K.; *Echinopepon wrightii* (A. Gray) S. Watson; *Marah gilensis* E. Greene; *Sicyosperma gracile* A. Gray.

EUPHORBIACEAE–*Acalypha neomexicana* Muell.-Arg.; *A. ostryaefolia* Riddell; *Argythamnia neomexicana* Muell.-Arg.; *Chamaesyce albo-marginata* (Torrey & A. Gray) Small; *C. arizonica* (Engelm.) Arthur; *C. capitellata* (Engelm.) Millsp.; *C. florida* (Engelm.) Millsp.; *C. hirta* (L.) Millsp.; *C. hyssopifolia* (L.) Small; *C. melanadenia* (Torrey) Millsp.; *C. pediculifera* (Engelm.) Rose & Standley; *C. serpyllifolia* (Pers.) Small; *C. setiloba* (Engelm.) Millsp. *ex* Parish; *C. vermiculata* (Raf.) House; *Croton pottsii* (Klotzsch) Muell.-Arg.; *Euphorbia exstipulata* Engelm.; *Jatropha cardiophylla* (Torrey) Muell.-Arg.; *J. macrorhiza* Bentham; *Manihot angustiloba* (Torrey) Muell.-Arg.; *Poinsettia heterophylla* (L.) Klotzsch & Garke var. *heterophylla*; *P. heterophylla* (L.) Klotzsch & Garke var. *graminifolia* (Michx.) Engelm.; *Tragia nepetaefolia* Cav.

FABACEAE–*Acacia angustissima* (Mill.) Kuntze; *A. greggii* A. Gray; *Astragalus allochrous* A. Gray; *A. arizonicus* A. Gray; *A. nothoxys* A. Gray; *A. nuttallianus* DC. var. *nuttallianus*; *A. nuttallianus* DC. var. *cedroensis* Jones; *A. wootoni* Sheldon; *Calliandra eriophylla* Bentham; *C. humilis* Bentham var. *reticulata* (A. Gray) L. Benson; *Cercidium floridum* Bentham; *Chamaecrista nictitans* (L.) E. Greene; *Crotalaria pumila* Ort.; *Dalea nana* Torrey var. *carnescens* (Rydb.) Kearney & Peebles; *D. pogonathera* A. Gray; *D. pulchra* Gentry; *Desmanthus cooleyi* (Eaton) Trel.; *Desmodium batocaulon* A. Gray; *Erythrina flabelliformis* Kearney; *Eysenhardtia orthocarpa* (A. Gray) S. Watson; *Galactia wrightii* A. Gray; **Lotus corniculatus* L.; *L. greenei* (Wooton & Standley) Ottley; *L. humistratus* E. Greene; *L. oroboides* (H.B.K.) Ottley; *L. salsuginosus* E. Greene; *Lupinus brevicaulis* S. Watson; *L. concinnus* Agardh.; *L. sparsiflorus* Bentham; *Macroptilium heterophyllum* (Willd.) Marechel & Baudet; *Marina calycosa* (A. Gray) Barneby; **Medicago polymorpha* L.; **Melilotus indicus* (L.) All.; *Mimosa biuncifera* Bentham; *M. dysocarpa* Bentham; *Nissolia schottii* (Torrey) A. Gray; *Parkinsonia aculeata* L.; *Prosopis velutina* Wooton; *Rhynchosia texana* Torrey & A. Gray; *Senna bauhinioides* (A. Gray) Irwin & Barneby; *Senna hirsuta* (L.) Irwin & Barneby; *Tephrosia tenella* A. Gray; *Trifolium wormskioldii* Lehm. var. *wormskioldii* [*T. lacerum* E. Greene]; *Vicia ludoviciana* Nutt.

FAGACEAE–*Quercus emoryi* Torrey; *Q. oblongifolia* Torrey; *Q. turbinella* E. Greene.

FOUQUIERIACEAE–*Fouquieria splendens* Engelm.

GERANIACEAE–**Erodium cicutarium* (L.) L'Her.; *E. texanum* A. Gray

HALORAGACEAE–*Myriophyllum exalbescens* Fern.

HYDROPHYLLACEAE–*Eucrypta micrantha* (Torrey) Heller; *Nama hispidum* A. Gray var. *spathulatum* (Torrey) C.L. Hitchc.; *Phacelia affinis* A. Gray; *P. arizonica* A. Gray; *P. coerulea* E. Greene; *P. distans* Bentham; *P. ramosissima* Douglas.

JUGLANDACEAE–*Juglans major* (Torrey) Heller.

KRAMERIACEAE–*Krameria parvifolia* Bentham var. *imparata* Macbr.

LAMIACEAE–*Agastache wrightii* (Greenman) Wooton & Standley; **Lamium amplexicaule* L.; **Marrubium vulgare* L.; *Stachys coccinea* Jacq.

LINACEAE–*Linum lewisii* Pursh; *L. puberulum* (Engelm.) Heller.

LOASACEAE–*Mentzelia albicaulis* Douglas; *M. asperula* Wooton & Standley; *M. multiflora* (Nutt.) A. Gray; *M. pumila* (Nutt.) Torrey & A. Gray.

LYTHRACEAE–*Lythrum californicum* Torrey & A. Gray.

MALPIGHIACEAE–*Janusia gracilis* A. Gray.

MALVACEAE–*Abutilon californicum* Bentham; *A. parvulum* A. Gray; *A. sonorae* A. Gray; *Anoda abutiloides* A. Gray; *A. cristata* (L.) Schlecht.; *Gossypium thurberi* Todaro; *Herissantia crispa* (L.) Briz.; *Hibiscus biseptus* S. Watson; *H. coulteri* Harvey; **Malva parviflora* L.; *Malvella leprosa* (Ort.) Krap.; *Rhynchosida physocalyx* (A. Gray) Fryxell; *Sida procumbens* Sw.; *S. spinosa* L. var. *angustifolia* (Lam.) Griseb.; *Sidalcea neomexicana* A. Gray; *Sphaeralcea angustifolia* (Cav.) G. Don; *S. emoryi* Torrey; *S. fendleri* A. Gray var. *venusta* Kearney.

MARTYNIACEAE–*Proboscidea altheaefolia* (Bentham) Decne.; *P. parviflora* (Wooton) Wooton & Standley.

MENISPERMACEAE–*Cocculus diversifolius* DC.

MORACEAE–*Morus microphylla* Buckl.

NYCTAGINACEAE–*Allionia incarnata* L.; *Boerhaavia coccinea* Mill.; *B. coulteri* (Hooker *f.*) S. Watson; *B. erecta* L.; *B. gracillima* Heimerl; *B. intermedia* Jones; *B. spicata* Choisy; *Commicarpus scandens* (L.) Standley; *Mirabilis longiflora* L.

NYMPHAEACEAE–**Nymphaea mexicana* Zucc.; **N. odorata* Ait.

OLEACEAE–*Forestiera shrevei* Standley; *Fraxinus velutina* Torrey var. *toumeyi* (Britton) Rehd.

ONAGRACEAE–*Camissonia californica* (Nutt. *ex* Torrey & A. Gray) Raven; *C. chamaenerioides* (A. Gray) Raven; *Epilobium canum* (E. Greene) Raven ssp. *latifolium* (Hooker) Raven; *Gaura coccinea* Nutt. var. *arizonica* Munz; *G. gracilis* Wooton & Standley; *G. parviflora* Douglas; *Ludwigia palustris* (L.) Ell.; *Oenothera albicaulis* Pursh; *O. flava* (A. Nelson) Garrett; *O. primiveris* A. Gray; *O. rosea* Ait.; *O. speciosa* Nutt.

OROBANCHACEAE–*Orobanche cooperi* (A. Gray) Heller.

OXALIDACEAE–*Oxalis albicans* H.B.K. ssp. *pilosa* (Nutt.) Eiten; *O. stricta* L.

PAPAVERACEAE–*Argemone pleiacantha* E. Greene ssp. *pleiacantha*; *Corydalis aurea* Willd.; *Eschscholtzia californica* Cham. ssp. *mexicana* (E. Greene) C. Clark.

PASSIFLORACEAE–*Passiflora foetida* L.; *P. mexicana* Juss.

PHYTOLACCACEAE–*Rivina humilis* L.

PLANTAGINACEAE–**Plantago major* L.; *P. patagonica* Jacq. var. *gnaphaloides* (Nutt.) A. Gray; *P. virginica* L.

PLUMBAGINACEAE–*Plumbago scandens* L.

POLEMONIACEAE–*Allophyllum gilioides* (Bentham) A. & V. Grant; *Eriastrum diffusum* (A. Gray) Mason; *Gilia mexicana* A. & V. Grant; *G. ophthalmoides* Brand. ssp. *australis* A. & V. Grant; *Ipomopsis longiflora* (Torrey) V. Grant; *Linanthus aureus* (Nutt.) E. Greene; *Microsteris gracilis* (Hooker) E. Greene.

POLYGALACEAE–*Polygala barbeyana* Chodat.

POLYGONACEAE–*Eriogonum abertianum* Torrey; *E. deflexum* Torrey var. *turbinatum* (Small) Reveal; *E. polycladon* Bentham; *E. thurberi* Torrey; *E. trichopes* Torrey; *E. wrightii* Torrey; **Polygonum aviculare* L.; **P. lapathifolium* L.; *P. pensylvanicum* L.; **P. persicaria* L.; *P. punctatum* Ell.; **Rumex crispus* L.; *R. hymenosepalus* Torrey.

PORTULACACEAE–*Calandrinia ciliata* (Ruiz & Pavón) DC.; *Calyptridium monandrum* Nutt.; *Portulaca retusa* Engelm.; *P. suffrutescens* Engelm.; *P. umbraticola* H.B.K.; *Talinum aurantiacum* Engelm.; *T. paniculatum* (Jacq.) Gaertn.

PRIMULACEAE–*Androsace occidentalis* Pursh.

RANUNCULACEAE–*Anemone tuberosa* Rydb.; *Clematis drummondii* Torrey & A. Gray; *Delphinium scaposum* E. Greene; *Myosurus cupulatus* S. Watson; *M. minimus* L.; *Ranunculus hydrocharoides* A. Gray; *R. macranthus* Scheele.

RHAMNACEAE–*Condalia mexicana* Schlecht.; *C. spathulata* A. Gray; *Sageretia wrightii* S. Watson; *Zizyphus obtusifolia* (Hooker) A. Gray var. *canescens* (A. Gray) M.C. Johnst.

ROSACEAE–*Potentilla rivalis* Nutt.

RUBIACEAE–*Diodia teres* Walt.; **Galium aparine* L.; *G. microphyllum* A. Gray; *G. proliferum* A. Gray; *Mitracarpus breviflorus* A. Gray.

SALICACEAE–*Populus fremontii* S. Watson; **Salix* cf. *babylonica* L.; *S. gooddingii* Ball; *S. tazifolia* H.B.K.

SAPINDACEAE–*Dodonaea viscosa* Jacq. var. *angustifolia* (L. *f.*) Bentham; *Sapindus saponaria* L. var. *drummondii* (Hooker & Arn.) L. Benson.

SAPOTACEAE–*Sideroxylon lanuginosa* Michx. [*Bumelia lanuginosa* (Michx.) Pers.

SAURURACEAE–*Anemopsis californica* (Nutt.) Hooker & Arn.

SCROPHULARIACEAE–*Antirrhinum nuttallianum* Benth.; *Linaria texana* Scheele; *Maurandya antirrhiniflora* Humb. & Bonpl.; *Mecardonia vandellioides* (H.B.K.) Pennell; *Mimulus floribundus* Douglas; *M. guttatus* DC.; *M. nasutus* E. Greene; *Orthocarpus purpurascens* Bentham; *Penstemon parryi* A. Gray; **Veronica anagallis-aquatica* L.; *V. peregrina* L. ssp. *xalapensis* (H.B.K.) Pennell.

SIMMONDSIACEAE–*Simmondsia chinensis* (Link) Schneid.

SOLANACEAE–*Datura meteloides* DC.; *Lycium andersonii* A. Gray; *L. exsertum* A. Gray; *Nicotiana trigonophylla* Dunal; *Petunia parviflora* Juss.; *Physalis hederaefolia* A. Gray; *P. longifolia* Nutt.; *P. pubescens* L.; *P. wrightii* A. Gray; *Solanum deflexum* Greenman; *S. douglasii* Dunal; *S. elaeagnifolium* Cav.; *S. lumholtzianum* Bartlett.

STERCULIACEAE–*Ayenia compacta* L.; *Waltheria americana* L.

TAMARICACEAE–**Tamarix ramosissima* Ledeb.

ULMACEAE–*Celtis pallida* Torrey; *C. reticulata* Torrey.

URTICACEAE–*Parietaria hespera* Hinton.

VERBENACEAE–*Aloysia gratissima* (Gill. & Hooker) Troncosa; *A. wrightii* (A. Gray) Heller; *Glandularia bipinnatifida* (Nutt.) Nutt. var. *bipinnatifida*; **Phyla cuneifolia* (Torrey) E. Greene; *Tetraclea coulteri* A. Gray; *Verbena bracteata* Lag. & Rodr.; *V. gracilis* Desf.; *V. neomexicana* (A. Gray) Small.

VIOLACEAE–*Hybanthus attenuatus* (Humb. & Bonpl.) G.K. Schulze; *H. verticillatus* (Ort.) Baill.

VISCACEAE–*Phoradendron californicum* Nutt.; *P. tomentosum* (DC.) A. Gray ssp. *tomentosum*.

VITACEAE–*Vitis arizonica* Engelm. var. *arizonica*

ZYGOPHYLLACEAE– *Kallstroemia californica* (S. Watson) Vail; *K. grandiflora* Torrey *ex* A. Gray; **Tribulus terrestris* L.

Monocotyledonae

AGAVACEAE–*Agave palmeri* Engelm.; *A. parviflora* Torrey; *A. schottii* Engelm. var. *schottii*; *Dasylirion wheeleri* S. Watson; *Nolina microcarpa* S. Watson; *Yucca arizonica* McKelvey; *Y. elata* Engelm.

COMMELINACEAE–*Commelina erecta* L.

CYPERACEAE–*Bulbostylis capillaris* (L.) C.B. Clarke; *Carex chihuahensis* Mack.; *C. praegracilis* W. Boott; *Cyperus dipsaceus* Liebm. [*C. wrightii* Britton]; *C. esculentus* L.; *C. flavicomus* Michx. [*C. albomarginatus* Mart. & Schrad.]; *C. mutisii* (H.B.K.) Griseb.; *C. odoratus* L.; *C. pallidicolor* (Kuk.) G. Tucker [*C. flavus* (Vahl) Nees]; *C. sphaerolepis* Boeck. [*C. rusbyi* Britton]; *C. squarrosus* L. [*C. aristatus* Rottb.]; *Eleocharis bella* (Piper) Svenson; *E. montevidensis* Kunth; *E. palustris* (L.) Roemer & Schultes; *Hemicarpha micrantha* (Vahl) Pax; *Scirpus californicus* (C. Mey.) Steud.; *S. olneyi* A. Gray.

IRIDACEAE–*Sisyrinchium demissum* E. Greene.

JUNCACEAE–*Juncus balticus* Willd.; *J. bufonius* L.; *J. tenuis* Willd. var. *tenuis*; *J. torreyi* Cov.

LEMNACEAE–*Lemna gibba* L.; *L. minima* H.B.K.; *L. minor* L.

LILIACEAE–*Allium macropetalum* Rydb.; *Anthericum torreyi* Baker; *Calochortus ambiguus* (Jones) Ownbey; *C. kennedyi* Porter var. *munzii* Macbr.; *Dichelostemma pulchellum* (Salisb.) Heller; *Nothoscordum texanum* Jones; *Zephyranthes longifolia* Hemsley.

POACEAE–*Agropyron trachycaulum* (Link) Malte; *Alopecurus carolinianus* Walt.; *Aristida adscensionis* L.; *A. hamulosa* Henr.; *A. orcuttiana* Vasey; *A. purpurea* Nutt. var. *longiseta* (Steud.) Vasey; *A. purpurea* Nutt. var. *purpurea*; *A. ternipes* Cav.; **Avena fatua* L.; *Bothriochloa barbinodis* (Lag.) Herter; *B. saccharoides* (Swartz.) Rydb.; *Bouteloua aristidoides* (H.B.K.) Griseb.; *B. barbata* Lag.; *B. chondrosioides* (H.B.K.) Bentham *ex* S. Watson; *B. curtipendula* (Michx.) Torrey; *B. eludens* Griffiths; *B. eriopoda* (Torrey) Torrey; *B. gracilis* (H.B.K.) Lag. *ex* Steud.; *B. hirsuta* Lag.; *B. repens* (H.B.K.) Scribn. & Merr.; *B. rothrockii* Vasey; *Brachiaria arizonica* (Scribn. & Merr.) S.T. Blake [*Panicum arizonicum* Scribn. & Merr.]; *Bromus arizonicus* (Shear) Stebbins; **B. catharticus* Vahl; *B. marginatus* Nees; **B. rubens* L.; *Cenchrus insertus* M.A. Curtis; *Chloris crinita* Lag.; *C. virgata* Swartz; *Cottea pappophoroides* Kunth; **Cynodon dactylon* (L.) Pers.; *Digitaria californica* (Bentham) Henr. [*Trichachne californica* (Bentham) Chase]; *D. cognata* (Schult.) Pilger [*Leptoloma cognatum* (Schult.) Chase]; *D. insularis* (L.) Mez *ex* Ekman [*Trichachne insularis* (L.) Nees]; **D. sanguinalis* (L.) Scop.; **Echinochloa crusgalli* (L.) Beauv.; *Elymus elymoides* (Raf.) Swezey [*Sitanion hystrix* (Nutt.) J.G. Smith]; *E. triticoides* Buck.; *Elyonurus barbiculmis* Hack.; *Enneapogon desvauxii* Beauv.; **Eragrostis curvula* (Schrad.) Nees var. *conferta* Nees [*E. chloromelas* Steud.]; **E. cilianensis* (All.) Vign.-Lutati *ex* Janchen; **E. echinochloidea* Stapf; *E. intermedia* A.S. Hitchc.; **E. lehmanniana* Nees; *E. pectinacea* (Michx.) Nees var. *miserrima* (Fourn.) J. Reeder; *E. pectinacea* (Michx.) Nees var. *pectinacea*; *Eriochloa acuminata* (Presl) Kunth [*E. gracilis* (Fourn.) Hitchc., *E. lemmonii* Vasey & Scribn.]; *Erioneuron pulchellum* (H.B.K.) Takeota; *Heteropogon contortus* (L.) P. Beauv. *ex* Roemer & Schultes; *H. melanocarpus* (Ell.) Bentham; *Hilaria belangeri* (Steud.) Nash; **Hordeum murinum* L. ssp. *glaucum* (Steud.) Tzvel. [*H. leporinum* Link]; *H. pusillum* Nutt.; *Leersia oryzoides* (L.) Swartz; *Leptochloa dubia* (H.B.K.) Nees; *L. filiformis* (Lam.) P. Beauv.; *Leptochloa viscida* (Scribn.) Beal; *Lycurus setosus* (Nutt.) C. Reeder; *Muhlenbergia arizonica* Scribn.; *M. asperifolia* (Nees & Mey.) Parodi; *M. emersleyi* Vasey; *M. fragilis* Swallen; *M. microsperma* (DC.) Kunth; *M. porteri* Scribn. *ex* Beal; *M. rigens* (Bentham) A.S. Hitchc.; **Panicum antidotale* Retz.; *P. hirticaule* Presl; *P. obtusum* H.B.K.; *P. pampinosum* A.S. Hitchc. & Chase; *P. stramineum* A.S. Hitchc. & Chase; *Paspalum distichum* L.; *Phalaris caroliniana* Walt.; **Poa annua* L.; *P. bigelovii* Vasey & Scribn.; **P. pratensis* L.; **Polypogon monspeliensis* (L.) Desf.; **Schismus barbatus* (L.) Thell.; *Schizachyrium cirratum* (Hack.) Wooton & Standley; *Setaria arizonica* Rominger; *S. geniculata* (Lam.) Beauv.; *S. grisebachii* Fourn.; *S. leucopila* (Scribn. & Merr.) K. Schum.; **Sorghum halepense* (L.) Pers.; *Sporobolus contractus* A.S. Hitchc.; *Sporobolus cryptandrus* (Torrey) A. Gray; *Sporobolus*

wrightii Munro *ex* Scribn.; *Trachypogon secundus* (Presl) Scribn.; *Trisetum interruptum* Buckl.; * *Triticum aestivum* L.; *Vulpia octoflora* (Walt.) Rydb.

PONTEDERIACEAE–*Heteranthera limosa* (Swartz) Willd.

POTAMOGETONACEAE–*Potamogeton foliosus* Raf.; *P. pusillus* L.

TYPHACEAE–*Typha domingensis* Pers.; *T. latifolia* L.

ZANNICHELLIACEAE–*Zannichellia palustris* L.

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SOLANUM SAXATILIS, A NEW WILD POTATO SPECIES FROM PERU

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ABSTRACT

Solanum saxatilis is described as new from Perú.

KEY WORDS: *Solanum*, Solanaceae, Perú, new species

During preparation of my monographic work on the wild tuber bearing *Solanum* (Sect. *Petota*) of Perú, I am still finding some hitherto unknown taxa. To provide a valid name, I here describe the following species:

Solanum saxatilis Ochoa *sp. nov.* TYPE: PERU. Dept. de Puno, prov. Sandia: Cerca de Ccaccapata, aprox. 3550 m en taludes muy empinados de suelos húmedos, negros y pedregosos, cerca de grandes rocas, asociada con *Stipa ichu* y *Duranta rupestris* Hayek y *Saracha biflora* R. et P., Feb. 19, 1983; *C. Ochoa y A. Salas 15082* (HOLOTYPE: Herb. OCH; Isotypes: CIP,MOL,MO). Pucpuquipata, aprox. 3650 m, cerca de Ccaccapata, entre suelos húmedos de acantilados y farallones rocosos, asociada con *Cortaderia* sp. y helechos herbáceos; *C. Ochoa y A. Salas 15606* (Paratypes: Herb. OCH,CIP,GH,MOL).

Herbaceum, tuberiferum. Plantae usque ad 1.50 m altae, robustae, caules erecti, simplici vel ramificati, trigoni, basi 1.5-1.8 cm crassi, per totam longitudinem spisse atro-violaceo maculati, etiam alae; alae 3.5 mm latae, rectae, raro sinuosae. Caules pilis brevibus, mollibus, albis sparsim obsiti, sed difficulter manifesti. Stolones 1-2 m longi, 2-3 mm crassi, tubera parva, 3.0-4.5 cm diam., rotunda, alba. Folia imparipinnata 15.0-18.0(-25.0) x 9.5-12.8(-17.0) cm, petioli 2-3(-4) cm longi, folia 3-4(-5)–juga; foliolis interjectis 2-3–juga. Foliola anguste elliptico-lanceolatae, apice acuto, subacuminato vel acuminato. Foliolum terminale lateralibus fere conforme, 5.0-7.2 x 1.0-2.5 cm, basi attenuatum. Foliola primi jugis supera

Solanum saxatilis Ochoa
(Drawn from holotypus *Ochoa et Salas 15082)*

4.7-6.7 x 1.0-1.7 cm, basi oblique rotundata, sessilia, aliquando in latere basiscopo in rhachidem decurrentia, foliola reliqua petiolulis pigmantatis 1-3 mm longis praedita. Foliola interjecta 2-10 mm longa, suborbicularia ad subelliptica, basi membranacea, sessilia. Omnia foliola pilis tenerioribus supra praedita, subtus venis venulisque pilis brevibus solum obtecta, rhachis pilis longioribus albis atque nitidis instructus. Foliola pseudostipulacea reniformia, sive late falcata, auriculiformia satis magna, 10-14(-20) x 6-8(-12) cm. Inflorescentia cymosa ad cymoso paniculata, 10-15(-30)–flora, pedunculus 8-10(-14) cm longus, basi 1.5-2.0(-2.5) mm crassus, pigmentatus sicut pedicelli et calyx, brevissime pilosi tamquam pedicelli. Pedicelli ad 1/3 supra articulati, pedicellus superior 3-4 mm longus, inferior 10-18 mm longus. Calyx 5.5 mm longus, rarenter pilosus, lobi late elliptico-lanceolatae, acumina paulo manifesta 1.0-1.5 mm longa, acuta. Corolla rotata, parva 2.5-2.8 cm diam., atro-lilacina, stella griseo-flavida, columna antherarum cylindrico-conica, asymmetrica, antherae 5.0-5.5 mm longae, anguste lanceolatae, basi cordatae. Filamenta albo-hialina, glabra 1.0-1.5 mm longa; stylus 8.5-9.0 mm longus, 1.5-2.0 mm exsertus, ca. 1/3 partis inferioris papillis dense obtectum, stigma parvum, styli apice vix crassius, dilute viridus. Ovarium globosum vel ovatum. Baccae 15-18 mm longae, globosae ad ovales, apicem versus pallide virides, ad basim atro-virides, lilacino-suffusae, pedicellus 5-6 mm longus. At series *Tuberosa* pertinent Numerus cromosomatum $2n=24$.

Habitat: In terrae praeruptis, non procul ab Ccaccapata, ad saxa et rupes, in locis humidis, inter *Stipa ichu*, *Duranta rupestris* Hayek, et *Saracha biflora* R. et P.

Solanum saxatilis has some far resemblance with *S. bukasovii* Juz.; however, in *S. saxatilis* the plant is taller, much more robust, the stem is thicker, never with a rosette at the base, and the average size of the corolla is smaller and more rotate.

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BULBOSTYLIS BARBATA, (CYPERACEAE), PREVIOUSLY UNREPORTED FOR TEXAS

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ABSTRACT

Bulbostylis barbata (Rottb.) Clarke *in* Hook. *f.*, previously unreported in Texas has been found in Newton County.

KEY WORDS: *Bulbostylis, Bulbostylis barbata*, Cyperaceae, Texas

There are at least 80 species of *Bulbostylis*, primarily on dry sandy situations in the warm temperate or tropical regions of the world. There are 26 species found in North America (Kral 1971). Four species are now present in Texas: *Bulbostylis barbata* (Rottb.) Clarke *in* Hook. *f.*, *B. capillaris* (L.) Clarke *in* Hook. *f.*, *B. ciliatifolia* (Ell.) Fern. var. *coarctata* (Ell.) Kral, and *B. juncoides* (Vahl) Kükenthal. Neither Correll & Johnston (1970), Kral (1971), Gould (1975), nor Hatch *et al.* (1990) have listed *Bulbostylis barbata* as occurring in Texas.

Kral (1971) stated that in North America *Bulbostylis barbata* is essentially a Coastal Plain weed, being a frequent invader of cultivated ground and common enough on sandy fields in late summer to form a reddish brown carpet of inflorescences. He goes on to state that it appears rapidly to be expanding its range in the southeastern United States. This range extension supports his observation. The following key will help differentiate this distinct taxon from the other *Bulbostylis* species in Texas.

KEY TO TEXAS *BULBOSTYLIS*

1. Inflorescence a solitary terminal cluster of hemispherical to globose sessile spikelets; achenes 0.6 mm long or less; scales glabrous and lustrous; plants of the coastal plains, southeast Texas. ..... *B. barbata*

1. Inflorescence a terminal simple or compound, open or compact, umbellate cyme; achenes longer than 0.6 mm; scales puberulent, rarely glabrous, dull not lustrous; plants of west to east Texas, and south. 2

    2. Achene faces with conspicuous horizontal lines; achenes conspicuously truncate apically, obtriangular, 0.9-1.5 mm long; plants perennial; plants of the Llano Uplift and of the Trans-Pecos. *B. juncoides*

    2. Achene faces with or without horizontal lines, but if present never conspicuous; achenes only slightly if at all truncate apically, obovoid or rarely pyriform, ca. 1 mm long; plants annual; plants from the Trans-Pecos east to the Piney Woods and south to the South Texas Plains. 3

        3. Fertile scales broadly obtuse at apex, the tip of the keel reaching the tip of the scale or barely exceeding it; achene faces minutely papillose (use 30X); plants from the Coastal Bend northeast to the Piney Woods. ..... *B. ciliatifolia* var. *coarctata*

        3. Fertile scales truncate at apex, the tip of the keel, at most, reaching the base of the notch; achene faces without minute papillae, but with faint horizontal lines; plants from the Trans-Pecos east to the Piney Woods, and south to the South Texas Plains. ..... *B. capillaris*

Specimen collected: UNITED STATES. Texas: Newton Co., ca. 25 m SE from the junction of Hwy 692 and Spur 135 in River Bend, 22 September 1992, *J.K. Wipff 2413 & E.J. Taylor* (BRIT/SMU). It was locally frequent growing on disturbed areas along the W side of a small ditch with running water in strongly acid sand of the Rayburn-Tehran-Kisatchie Association. The elevation of the site is ca. 33 m (110 feet) with the geology being of the Catahoula Formation (Ms) (Oligocene). Associated taxa: *Carex longii* Mackenzie, *Cyperus compressus* L., *C. haspan* L., *C. polystachyos* Rottb., *Dactyloctenium aegytium* (L.) P. Beauv., *Eleusine indica* (L.) Gaertn., *Fimbristylis miliacea* (L.) Vahl, *Kyllinga odorata* Vahl, *K. pumila* Michx., *Myriophyllum aquaticum* (Vell.) Verd., and *Sacciolepis indica* (L.) Chase.

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CASTILLEJA SECTION *EUCHROMA* (SCROPHULARIACEAE) IN MEXICO: NEW SPECIES AND COMMENTS ON OTHER TAXA

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ABSTRACT

Two new species of *Castilleja* sect. *Euchroma* are described from Tamaulipas, México: **C. porphyrosceptron** from the Sierra de Guatemala in the Gómez Farías area and **C. papilionacea** from the Sierra de San Carlos. The identity of *C. cryptandra* is clarified, and range extensions are noted for several other species of the section.

KEY WORDS: *Castilleja*, Scrophulariaceae, México

The Mexican collections of *Castilleja* housed at MICH provide a rich source of information regarding the genus. Represented among nearly 700 such collections there are two previously undescribed species. Both are members of sect. *Euchroma* (Nutt.) Benth. (sensu Eastwood 1909).

Castilleja porphyrosceptron Nesom, *sp. nov.* TYPE: MEXICO. Tamaulipas: [Sierra de Guatemala,] La Lagunita valley, 4 km by road NW of Aserradero La Gloria, ca. 10-12 km WNW of Gómez Farías, montane, mesic pine-oak-madroño forest, with *Myrica* and other shrubs, wet grassy area in the forest, 1900 m, 4 Jun 1953, *P.S. Martin H31* (MICH).

A speciebus affinibus *Castilleja* sect. *Euchroma* dignoscenda plantis tenuibus ut videtur rhizomatibus tenuibus efferentibus, caulibus ac foliis glabris, foliis lineari-lanceolatis, calyces aequaliter divisis lobis ad apices rotundatis, et bracteis floralibus superis ac apicibus calycum purpuratis.

Short lived perennials, apparently arising from very slender rhizomes, the stems and leaves glabrous. Stems erect, 17-28 cm tall, ca. 1 mm wide at the base. Leaves linear-lanceolate with an acuminate apex, entire, clasping,

closely ascending-appressed, overlapping on the stem, 1-3 cm long, 1-2 mm wide, gradually reduced in size upwards, the uppermost similar to the lower floral bracts. Inflorescence 2-4 cm long, with ca. 4-7 sessile flowers; lower floral bracts green, the upper with purple tips; upper bracts and sepals crinkly villous along veins and margins. Calyx 17-21 mm long, narrowed near the base, widening distally, the upper 2/3 purple to red-purple and short stipitate glandular near the apex, whitish near the base, primary clefts 6-8 mm deep, the lobes rounded to very slightly emarginate. Corollas 19-24 mm long, the galea 8-9 mm long, ca. 1/3 as long as the corolla, exserted 3-5 mm from the calyx, the galea with red margins, the dorsal surface viscid-villous with short hairs, lower lip of 3 thick, green, lanceolate teeth ca. 1 mm long; stigmas narrowly clavate. Capsules ovate, 7-8 mm long. Known only from the type collection.

Castilleja porphyrosceptron is distinctive in the following combination of features: very slender plants apparently arising from thin rhizomes, glabrous stems and leaves, linear-lanceolate leaves, evenly divided calyces with rounded lobe tips, and the apices of the calyces and upper floral bracts purple. In its calyx morphology (constricted near the base, widening distally), the new species clearly belongs to the group of species including and related to *C. scorzoneraefolia* Kunth. In its very slender stems and rhizomatous habit, *C. porphyrosceptron* is at least superficially similar to *C. chlorosceptron* Nesom (from Durango and Chihuahua); the latter, however, has minutely hispidulous stems and red tipped, triangular calyx lobes, features that appear to ally it more closely with other species of the western sierra. In view of its purple bracts and calyces, as well as its geographical position, the new species may be closely related to *C. nitricola* Eastwood. The latter is a rare species endemic to saline plains of northeastern San Luis Potosí, and it is the only other species of *Castilleja* in México with consistently purple colored calyces and floral bracts. *Castilleja nitricola*, however, is more like *C. scorzoneraefolia* in habit (more robust, without rhizomes, with lanceolate leaves).

Only two other species of *Castilleja* are known from the Sierra de Guatemala area of Tamaulipas: *C. arvensis* Cham. & Schlecht. and *C. integrifolia* L. *f.* (Johnston *et al.* 1989; the latter species mistakenly reported as *C. tenuiflora* Benth.).

Castilleja papilionacea Nesom, sp. nov. TYPE: MEXICO. Tamaulipas: Sierra de San Carlos, vicinity of San José, La Vegonia, 3400 ft, 6 Jul 1930, *H.H. Bartlett 10138* (HOLOTYPE: MICH!).

Castillejae scorzoneraefoliae Kunth similis sed differt foliis oblanceolatis, bracteis floralibus ac sepalis flavis, et bracteis floralibus late oblanceolatis.

Perennial herbs from slender but woody roots. Stems 22-35 cm tall, arising mostly singly from the base, invested with a mixture of long, stiff, vitreous hairs 1-2 mm long and shorter, soft hairs, many of the latter stipitate-glandular. Leaves oblanceolate, 2-6 cm long, 4-7 mm wide, 3 veined, subclasping, hairy above and beneath. Inflorescence 3-6(-15) cm long; floral bracts broadly oblanceolate, mostly 20-32 mm long, (11-)14-20 mm wide, yellow distally, green near the base. Calyces 17-24 mm long, narrowed near the base, widening distally, the primary cleft 9-10 mm deep, with lobes 7-9 mm wide, rounded or slightly emarginate apically. Corollas 23-27 mm long, the galea 7-9 mm long, ca. 1/3 the corolla length, exserted 4-6 mm from the calyx, margins yellow, the dorsal surface viscid villous with short hairs, the lower lip of 3 thick, green teeth ca. 1 mm long. Fruits elliptic-lanceolate, 9-11 mm long.

Additional collections examined: MEXICO. Tamaulipas, Sierra de San Carlos, vicinity of San José: La Vegonia, 3200 ft, 5 Jul 1930, *Bartlett 10078* (MICH); Cerro de los Armadillos, 9 Jul 1930, *Bartlett 10187* (MICH); near crest of ridge above Mesa de Tierra, 12 Jul 1930, *Bartlett 10273* (MICH).

In a summary of the flora and vegetation of the Sierra de San Carlos, Briones (1991) listed four collections of *Castilleja* but did not identify them. In my own studies of the genus, I have seen no species other than *C. papilionacea* from that area.

Castilleja papilionacea is immediately distinguished by its oblanceolate leaves, yellow floral bracts and calyces, and broadly obovate floral bracts. It is closely related to the widespread *C. scorzoneraefolia* Kunth, but the new species appears to be isolated on the northeasternmost periphery of the range of the former (Nesom 1992a, Map 1). Oblanceolate leaves rarely occur in *C. scorzoneraefolia* (with lanceolate leaves) but are characteristic of two other of its close relatives, *C. hirsuta* Benth. and *C. falcata* Eastwood. Floral bracts are mostly oblanceolate in *C. scorzoneraefolia* (mostly 5-9 mm wide, rarely to 13 mm), much narrower than in *C. papilionacea*. Yellow bracted variants are common in other primarily red bracted *Castilleja* species of México (e.g., *C. tenuiflora* Benth. and *C. integra* A. Gray), but they are rare in *C. scorzoneraefolia*. Among more than 650 collections (GH,MICH,NY,SMU,TEX,WIS) of the latter species, I have seen only one yellow bracted collection: Oaxaca, vicinity of Cerro Zempoaltepetl, *Hallberg 741* (MICH). In its set of distinctive features and its isolated locality, without intergrading forms, *C. papilionacea* is justifiably regarded as a separate species.

The identity of *Castilleja cryptandra* Eastwood

In an earlier paper (Nesom 1992a), I placed *Castilleja cryptandra* Eastwood as a synonym of *C. nervata* Eastwood. After examining MICH collections from Nevado de Colima, however, of a species strongly differentiated from *C.*

nervata, it appears that the endemic from Nevado de Colima can justifiably be represented by the name *C. cryptandra*. The plants of the type collection of *C. cryptandra* are similar to *C. nervata* in their included corollas (hence the epithet) and green calyces, and they almost certainly are of hybrid origin between *C. nervata* and the endemic of Nevado de Colima. Nevertheless, the plants of the type produce enough of the distinctive features of the endemic to obviate the necessity of formalizing another name for it. The two species are contrasted in the following couplet.

1. Plants mostly with 1-3 erect stems arising from the base; leaves not at all clasping; upper floral bracts red tipped, the lower red tipped or all green; calyces all green, the lobes rounded or barely emarginate; corollas included within the calyces. ..... *C. nervata*

1. Plants caespitose, with numerous (up to 15) ascending stems arising from the base; leaves strongly clasping to subclasping; upper floral bracts red from near base to apex, the lower bracts red tipped; calyces crimson-red from near the base to apex, the lobes with secondary clefts 2-4 mm deep; corollas conspicuously exserted (3-6 mm) from the calyces. *C. cryptandra*

The following collections of *Castilleja cryptandra* have been examined from MICH: MEXICO. Jalisco: Nevado de Colima: N slope, La Joya, 10900 ft, 20 Nov 1968, *Boutin & Brandt 2308*; 18.9 mi by road NW of intersection of road to Nevado and road between Atenquique and Tonila, pine-oak-fir zone, pedregal and ash with shrubs and perennials growing among rocks, 2890 m, 12 Aug 1972, *Denton 2062*; NE slopes, above Canoa de Leoncito, steep mountainsides in alder-zacaton zone, locally abundant on rocks along waterline, 3100-3300 m, 13 Sep 1952, *McVaugh 12895*; upper slopes of the peak, near timberline and above, abundant on steep rocks, 3300-4340 m, 13 Sep 1952, *McVaugh 12910*.

Comments on other taxa of sect. *Euchroma*

The collections at MICH have added additional information regarding recently described species of *Castilleja*. The two collections of *C. chlorosceptron* in the initial description (Nesom 1992b) were noted as being widely separated within the state of Durango. A third collection extends its range northward into Chihuahua: MEXICO. Chihuahua: Cerro Mohinora, 11 Aug 1960, *Straw & Forman 1980* (MICH). An isotype and duplicate of the single paratype of *C. zempoaltepetlensis* Nesom (Nesom 1992c) also are housed at MICH. The range of *C. scorzoneraefolia* is now known to extend as far northwest as southern Chihuahua: MEXICO. Chihuahua: Cerro Mohinora, 11 Aug 1960, *Straw & Forman 1971* (MICH).

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TAXONOMY OF THE *CASTILLEJA TENUIFLORA* GROUP (SCROPHULARIACEAE) IN MEXICO, WITH AN OVERVIEW OF SECT. *CASTILLEJA*

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ABSTRACT

Castilleja tenuiflora, *C. auriculata*, and *C. integrifolia* (sect. *Castilleja*) are closely related species widely distributed in México. *Castilleja integrifolia* is broadly sympatric with the other two, which have separate though significantly overlapping geographic distributions. One new species is recognized from within the *C. tenuiflora* group, **C. tancitaroana**, which occurs from Nayarit to Veracruz and Oaxaca. Two varieties are recognized in *C. tenuiflora*, including the yellow bracted var. **xylorrhiza** *comb. et stat. nov.* from northeastern México. Two varieties are recognized within *C. auriculata*: var. *auriculata* and var. **verecunda** *var. nov.* Three other Mexican species more peripherally related to *C. tenuiflora* are described: **C. stipifolia**, from Jalisco to Edo. México and Guerrero; **C. filiflora**, from east central Chiapas; and **C. perelegans**, endemic to southern Durango. One new combination is proposed: **Castilleja subinclusa** var. **franciscana** *comb. et stat. nov.* A key is provided for identification of the eighteen Mexican and Guatemalan species of sect. *Castilleja* and seven other species with an irregularly cleft calyx.

KEY WORDS: *Castilleja*, Scrophulariaceae, México

The species of *Castilleja* sect. *Castilleja* (sect. *Hemichroma* Benth., *sensu* Eastwood 1909; sect. *Linariifolia* Pennell, Pennell 1951) include the South American generitype, *C. fissifolia* L. *f.*, and are primarily characterized by calyces with a deeply cut (anterior) abaxial cleft and shallow (posterior) adaxial one, the lateral clefts absent or relatively shallow notches. Other characteristic but more variable features of the group are a racemose inflorescence, colored calyces but green floral bracts, and the galea as long or longer than the corolla

tube (Holmgren 1976, 1978). There are two other species groups that produce irregularly divided calyces: those with annual duration (one perennial species), pectinately divided leaves, and a relatively short galea are placed in sect. *Epichroma* Benth.; two species transitional between sect. *Castilleja* and sect. *Epichroma* are without a formal taxonomic designation but referred to by Holmgren (1976) as "the Ortegae group" (see key below). A hypothesis of close evolutionary relationship among these three groups must be regarded as speculative, but based on their calyx morphology, they are distinct from the rest of the genus. All three are a part of subg. *Castilleja* (sensu Chuang & Heckard 1991).

About twenty-six species are now recognized within sect. *Castilleja*, eighteen from México, six others endemic to Central America (Holmgren 1978). *Castilleja fissifolia* is endemic to South America. Five species occur in the United States: *Castilleja linariifolia* Benth., *C. patriotica* Fern., and *C. tenuiflora* Benth. occur both in northwestern México and in the southwestern United States; *C. wootonii* Standley is closely related to *C. linariifolia* but is isolated in southeastern New Mexico and adjacent Texas (Nesom 1992a); *C. franciscana* Penn., *C. subinclusa* E. Greene, and *C. jepsonii* Bacig. & Heck. are primarily endemic to California, the latter also occurring in Baja California (see Holmgren 1976). The last three species have been regarded as closely related among themselves (Bacigalupi and Heckard 1966), and Chuang and Heckard (1992) have treated them as a single species. The Ortegae group (two species) and all species of sect. *Epichroma* (six) are restricted to México, except for *C. tayloriorum* N. Holmgren, which is endemic to Costa Rica.

Three common Mexican species of sect. *Castilleja*, *C. tenuiflora*, *C. auriculata* Eastw., and *C. integrifolia* L. *f.*, have often been confused in identification. Holmgren's treatment (1976) reviewed the taxonomy of the *C. tenuiflora* group but dealt with only part of the complexity among the more widespread taxa. The present study concentrates on these and completes my taxonomic study of *Castilleja* in northeastern México (Nesom 1992b). While additional Mexican species of sect. *Castilleja* may yet be discovered, these will almost certainly be narrow endemics, and the study presented here will provide further background for their interpretation.

I. Variation in *Castilleja tenuiflora* Benth.

Castilleja tenuiflora Benth., *Pl. Hartweg.* 22. 1839. TYPE: MEXICO. Bentham cited neither a locality nor a specific Hartweg collection. The sequential listing in *Plantae Hartwegianae* is "191;" Holmgren (1976) cited "*Hartweg 191*" from Aguascalientes in 1837 as the type.

Castilleja tenuiflora var. *tenuiflora*

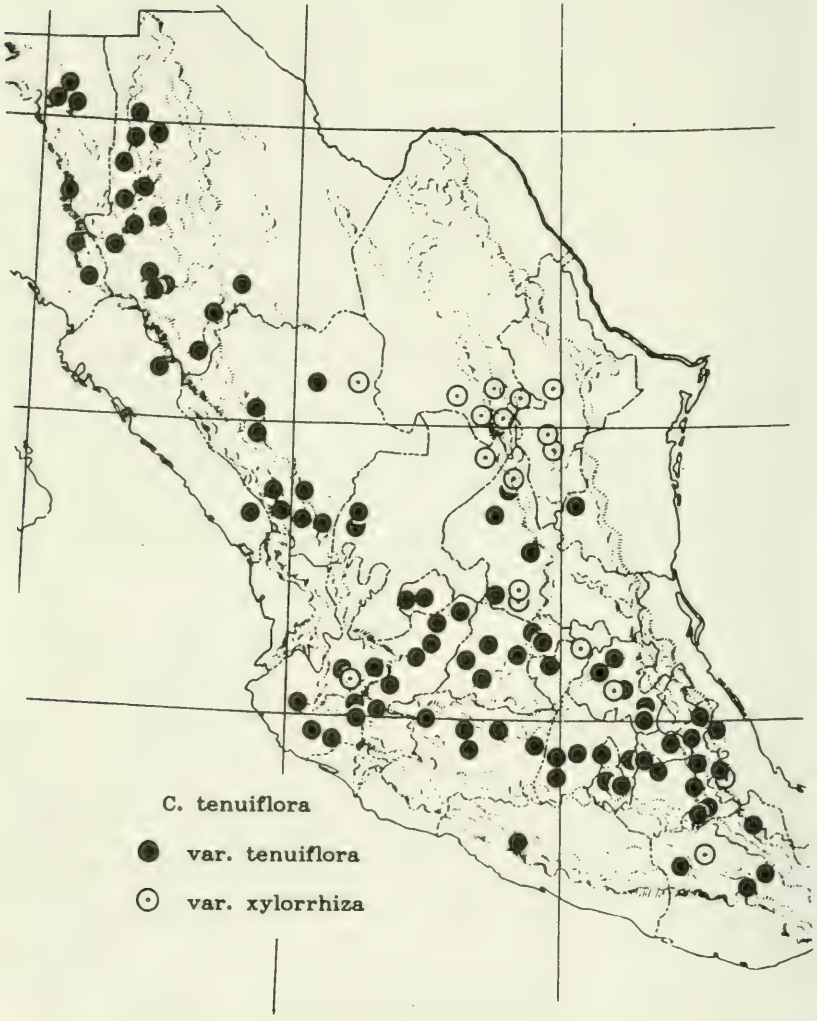
Castilleja longiflora Kunze, Linnaea 16:312. 1842. TYPE: MEXICO. Locality unspecified, but apparently grown from seeds collected by Ehrenberg in a "cold region" of México. I have not seen type material, but the original publication clearly describes a plant similar to *C. tenuiflora*. Eastwood (1909) maintained *C. longiflora* as a separate species closely related to *C. auriculata* (see further comments below), identifying the two as a pair in her key on the basis of glandular vestiture, but she did not indicate that she studied the type of *C. longiflora*. There is no reference at all in Kunze's original description to vestiture, one of the most distinctive features of *C. auriculata*, and without the specimen, there is no reason to assume that it is glandular. Bentham (*in* DC., *Prodr.* 10:533. 1846.), who noted that he studied the Ehrenberg specimen, described the vestiture of *C. longiflora* as canescent-hispid, without any mention of glandularity; he further observed that *C. longiflora* is scarcely different from *C. canescens*, and compared *C. tenuiflora* with both *C. canescens* and *C. longiflora*, noting as differences among the features accepted here as within the bounds of *C. tenuiflora*.

Castilleja canescens Benth. *in* DC., *Prodr.* 10:533. 1846. LECTOTYPE (designated here): MEXICO. Edo. México: circa Tolucam, April 1832, *Andrieux 156* (G-DC fiche!). This is a full specimen, a single plant, clearly identified and annotated. Bentham also cited *Berlandier 660* and *1213* and *Galeotti 992* and *1087*.

Castilleja laxa A. Gray *in* Emory, *Rep. U.S. & Mex. Bound. Survey* 2(1):119. 1858. TYPE: MEXICO. Sonora: mountain sides near Santa Cruz, 1851, *C. Wright 1490* (HOLOTYPE: GH!; Isotypes: GH-2 sheets!). See Boufford & Nesom (in prep.) for comments.

Castilleja scabridula Eastw., Proc. Amer. Acad. Arts 44:586. 1909. TYPE: MEXICO. Durango: Tejamen, Aug 1906, *E. Palmer 468* (HOLOTYPE: GH!; Isotype: MO!).

Sonora, Chihuahua, Sinaloa, Durango, Zacatecas, San Luis Potosí, Tamaulipas, Jalisco, Aguascalientes, Guanajuato, Hidalgo, Puebla, Veracruz, Tlaxcala, Michoacán, México, Distrito Federal, Morelos, Guerrero, Oaxaca (Map 1); matorral to oak, pinyon-juniper, oak, pine, and fir woods, roadside banks, rocky slopes, (1350-)1700-3000(-3900) m; all year but apparently less commonly April-June.



Map 1. Distribution of *Castilleja tenuiflora* (var. *tenuiflora* and var. *xylorrhiza*). Var. *tenuiflora* also occurs in southern Arizona. Yellow bracted plants south of San Luis Potosí are best regarded as populational variants of var. *tenuiflora* (see text for comments).

Holmgren (1976) provided taxonomic details regarding two other taxa that he considered to be synonyms of *Castilleja tenuiflora*: *C. retrorsa* Standley and *C. setosa* Pennell, both from southeastern Arizona. Such plants from this area need to be evaluated in more detail, as at least some of them appear to be significantly different from *C. tenuiflora* in aspects of their vestiture.

Distinctions among most of the taxa that Eastwood recognized as closely related to *Castilleja tenuiflora* are accepted here as aspects of variation within a single species. In northern Durango, Chihuahua, and Sonora many plants (including the type specimens of *C. laxa* and *C. scabridula*) characteristically produce flowers on pedicels 2-4 mm long and leaf bases with a tendency to be basally attenuate and nonauriculate, at least on the upper portion of the stem, and the plants perhaps are shorter in duration. In the same area, however, are more typical plants and apparently intergrading forms; field work will be valuable in further interpretation of the variation.

Plants of *Castilleja tenuiflora* with spreading-ascending (vs. descending) stem hairs occur sporadically throughout the range of the species, and they are not regarded as taxonomically significant. Plants with glandular vestiture, often identified as *C. tenuiflora*, are treated here as *C. auriculata* Eastw. and *C. tancitaroana* Nesom (see below). Holmgren (1976) apparently included both within his concept of *C. tenuiflora*, although he did not mention variability in vestiture.

Castilleja tenuiflora Benth. var. **xylorrhiza** (Eastw.) Nesom, *comb. et stat. nov.* BASIONYM: *Castilleja xylorrhiza* Eastw., Proc. Amer. Acad. Arts 44:586. 1909. TYPE: MEXICO. Coahuila: Sierra Encaruaciore, 28 Jul 1896, *E. W. Nelson 3895* (HOLOTYPE: GH!).

Durango, Coahuila, Nuevo León, Zacatecas, San Luis Potosí, and as yellow variants within var. *tenuiflora*, Querétaro, Hidalgo, Veracruz, and Oaxaca (Map 1); chaparral to pinyon pine, oak, oak-juniper, or pine-oak woodlands, limestone and gypsum, 1200-2550 m; (May-)June-November.

Plants of var. *xylorrhiza* produce yellow bracts and calyces, without any red coloration, and although the difference is striking and easily discernible, they appear to be similar in all other respects to those of typical *Castilleja tenuiflora*. In Nuevo León and Coahuila, var. *xylorrhiza* essentially replaces the typical, red bracted plants, which have a much wider geographic range (Map 1). Both "red" and "yellow" forms apparently occur within the same population in areas where the geographic ranges of the two varieties meet, primarily in southeastern Coahuila and adjacent areas of northern Zacatecas and San Luis Potosí. For example, in the Sierra de Catorce (W of Matehuala, San Luis Potosí, 24 July 1934, GH) Pennell collected both red (*17517*) and yellow (*17525*) forms; in San Lorenzo Canyon (S of Saltillo, Coahuila, 22 July 1934, GH), he collected both color forms and intermediates (*17499*-red, *17501*-

yellow, *17503*-orange). Numerous other collections (TEX) have been made from San Lorenzo Canyon and show the same pattern of variation.

Yellow bracted plants of *Castilleja tenuiflora* occur mostly along the eastern periphery of the range of the species in areas where the typical variety is more common: MEXICO. San Luis Potosí: Sierra de Alvarez, *Pennell 17748* (GH,MICH) and *17800* (GH,MICH) and La Salitrera, 20 km W of Zaragoza, *Rzedowski 6132* (MICH); Hidalgo: Dist. Actopan, Cerro de las Canteras, *Moore 1484* (GH) and near Yolotepec, *Lundell 12536* (LL,MICH); Querétaro: between Jalpan and Cadereyta on Hwy 120, *Daniel 372* (MICH); Veracruz: 3-4 km NE of summit of Puebla-Orizaba road, *Cruden 1123* (GH,MICH); Oaxaca: 3 mi S of Yanhuitlán, *Woodruff 456* (TEX,MEXU); Jalisco: above Zapotitan de Hidalgo, ca. 25 mi due S of Guadalajara, *Gregory & Eiten 246* (MICH). I have mapped these variants southward as var. *xylorrhiza*, but south of San Luis Potosí, they are best regarded as populational variants of var. *tenuiflora*. Their distribution, however, suggests that they once may have been more discontinuously differentiated from the red bracted plants.

Holmgren (1976, p. 199) observed that the "race" of *Castilleja tenuiflora* in the Sierra Madre Oriental has "predominantly yellow to orange coloration and more open, often secund inflorescences, most with longer pedicels." His annotations, however, show that the perception of such putative complexity resulted primarily from the inclusion of two species in his concept of this "race": (1) the yellow bracted plants identified here as *C. tenuiflora* var. *xylorrhiza*, and (2) red bracted plants with long pedicellate flowers in open inflorescences, identified here as *C. integrifolia* L. *f.* In northeast México, the two species occur over a similar range of elevations, but *Castilleja tenuiflora* tends to grow in rockier, more xeric habitats. While there is some degree of intergradation between these two species in their areas of sympatry, they are clearly distinct and separated by the following contrasts:

1. Leaves basally amplicate, subclasping, all evenly hirsutulous to strigose hirsute both surfaces; stem hairs spreading, usually slightly deflexed, sometimes ascending; inflorescence densely compact, without apical bracts; calyx apically red or yellow, 16-27 mm long, the abaxial cleft 12-18 mm deep; flowers sessile or on pedicels 1-6 mm long; corollas 27-31 mm long, the galea 18-21 mm long and without a prominent beard. *C. tenuiflora*

1. Leaves basally attenuate, not at all subclasping, at least the upper leaves and bracts with upper surfaces glabrous to glabrate; stem hairs retrorsely appressed; inflorescence open, the internodes 10-25 mm long, with a cluster of red bracts at the very apex; calyx apically red or greenish, 21-38 mm long, the abaxial cleft 16-31 mm deep; flowers on pedicels 10-20 mm long; corollas 30-40 mm long, the galea 21-28 mm long and densely bearded, at least at the apex. ..... *C. integrifolia*

II. *Castilleja integrifolia* L. *f.* and its closest relatives in México

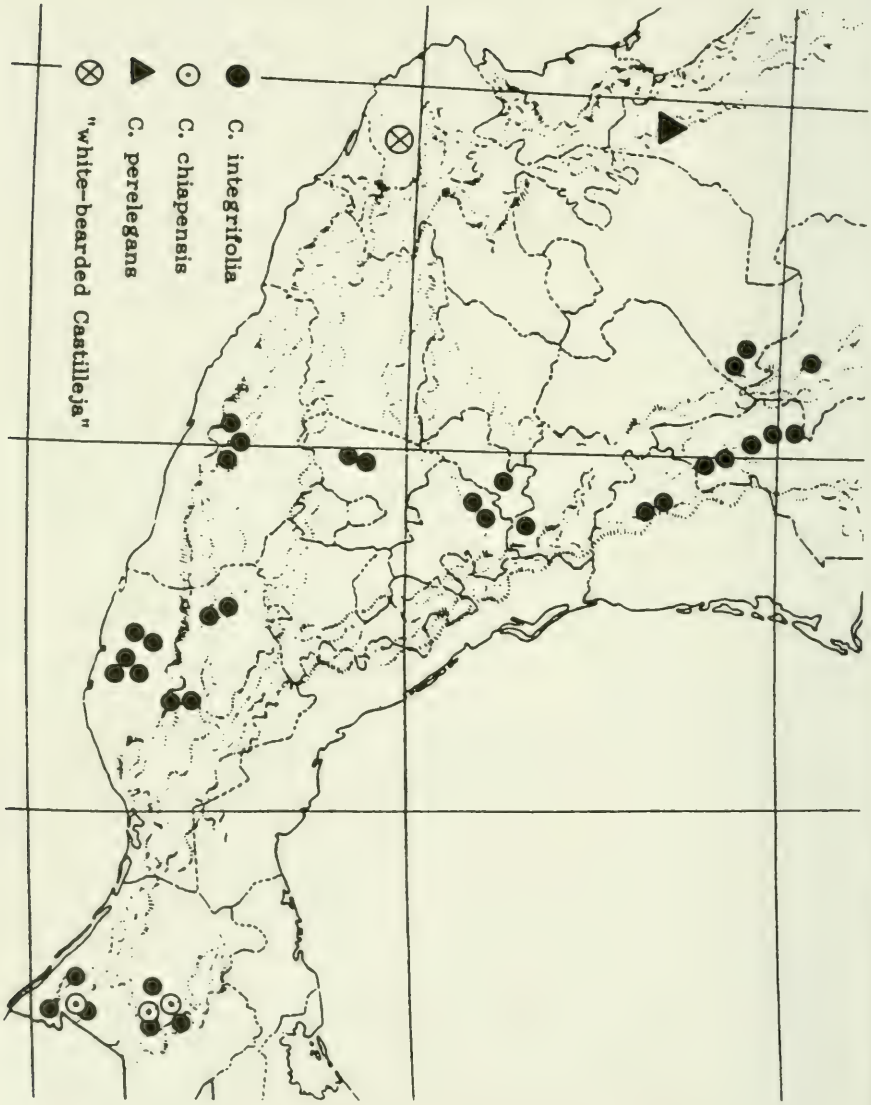
Castilleja integrifolia L. *f.*, *Supplem. Pl.* 293. 1781. TYPE: COLOMBIA. Locality not specified, 1877, *Mutis s.n.* (LINN fiche!). The specimen clearly shows lanceolate leaves with an attenuate, nonclasping base, unevenly divided calyces, and long pedicels, but the nature of the vestiture is not clear from the fiche.

Castilleja longibracteata Mart. & Gal., Bull. Acad. Roy. Sci. Bruxelles 12(2):28. 1845. SYNTYPES: MEXICO. Oaxaca: dans le bois de Juquila del Sur (cote pacifique), 5000 ft, *Galeotti s.n.*; Oaxaca: a Talea et dans le Rincón (cordill. Orientale), 3000-4000 ft, Sep, *Galeotti s.n.* This taxon was noted by Eastwood (in her key and discussion) to differ from *C. integrifolia* by its larger, longer peduncular bracts, the upper ovate and apically fimbriate, these comments essentially adopted from the original description of Martens & Galeotti. I have found no pattern of variability within *C. integrifolia*-like plants, with the caveats below regarding *C. chiapensis* Brandg. and the new species from Jalisco, that would support recognition of more than one species.

Coahuila, Nuevo León, Tamaulipas, Querétaro, Hidalgo, Edo. México, Guerrero, Oaxaca, Chiapas, to Guatemala, Honduras, and El Salvador (Map 2); oak-pine, pine, and pine-fir woods, 1500-3300(-3650) m; July-November (-December, January).

As noted by Holmgren (1978), typical *Castilleja integrifolia* may prove to be restricted to South America, but the species that occurs from Central America into northeastern México has been identified as such by Williams (1973). The species in México and Central America can be consistently recognized, and even though variation is accepted within it, there is no more than occurs in other relatively widespread species of the genus. I have not evaluated the status of *C. integrifolia* var. *alpigena* L. Wms. from Guatemala, but it appears to be either a distinct species or else conspecific with the Mexican species *C. pectinata* Mart. & Gal. Otherwise, the most distinctive variants of *C. integrifolia* are among the plants from Nuevo León, Coahuila, and northern Zacatecas, which tend to produce broader and shorter leaves than elsewhere in the range, perhaps in response to the genetic influence of sympatric *C. tenuiflora*. Along the Atlantic slope of the sierra in Nuevo León, however, and in Tamaulipas, the plants are similar to those further south, and there is little justification for assigning the northern populations more than informal recognition.

Castilleja integrifolia apparently is absent from the Sierra Madre Occidental, but variant forms of *C. tenuiflora* approach it in some respects. The distinction of a previously undescribed species from the Sierra Manantlán of



Map 2. Distribution of *Castilleja integrifolia*, *C. chiapensis*, *C. perelegans*, and the "white-bearded *Castilleja*." The distribution of *C. integrifolia* continues into Central America (see text).

Jalisco (Map 2), closely related to *C. integrifolia*, is discussed in detail by Iltis & Nesom (in prep.).

Castilleja chiapensis Brandegee, Univ. California Publ. Bot. 6:62. 1914. TYPE: MEXICO. Chiapas: high region of Cerro del Boquerón, Aug 1913, *C.A. Purpus 6884* (HOLOTYPE: UC; Isotype: GH!).

Central to southeastern Chiapas (Map 2); oak to oak-mixed deciduous woods, 1750-2500 m; June-September(-January).

Plants of *Castilleja chiapensis* are closely similar to *C. integrifolia* in habit and general morphology, but the stems, bracts, and calyces are densely villous with loose, spreading, yellow tinged hairs, often dense enough to completely obscure the surface (vs. glabrate to sparsely hispidulous), and the terminal bracts of the inflorescence are apically lobed or toothed (vs. entire). Further, *C. chiapensis* appears to be sympatric with typical *C. integrifolia*, and at least until field work may provide more detailed information, the two taxa can be maintained as separate species.

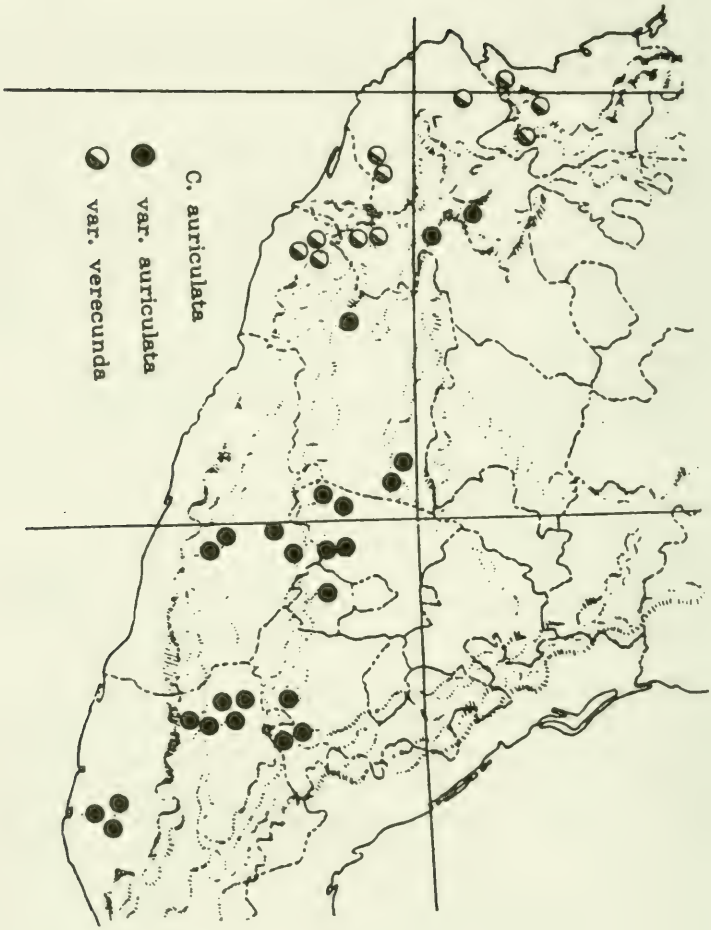
III. Variation in *Castilleja auriculata* Eastw.

Castilleja auriculata Eastw., Proc. Amer. Acad. Arts 44:583. 1909. TYPE: MEXICO. Oaxaca: between Huajuapan and Retlatzingo, Puebla, 19 Nov 1894, *E.W. Nelson 1992* (HOLOTYPE: GH!; Isotype: US).

Castilleja auriculata has not been generally recognized since Eastwood's treatment, but it is a good species distinguished from *C. tenuiflora* particularly by its densely glandular leaf vestiture and pilose-villous stems. Var. *auriculata* is set apart from all of the rest of the *C. tenuiflora* group by its strongly auriculate-clasping leaves. *Castilleja auriculata* and *C. tenuiflora* are allopatric over a major part of their distributions, but they overlap along the northern periphery of the range of *C. auriculata* (Maps 1 and 3) without the production of unequivocal hybrids (see notes below regarding *C. tancitaroana*).

Eastwood (1909) recognized two species with a spicate inflorescence, deeply and irregularly cleft calyces, long flowers, and glandular vestiture: *Castilleja auriculata* and *C. longiflora* Kunze. Her key couplet separates *C. longiflora* by its ovate-lanceolate, nonimbricate leaves (vs. deltoid, densely imbricate leaves), and she offered the following comment (p. 583) regarding *C. auriculata*: "This species is nearest to *C. longiflora*, differing most noticeably in its broader, conspicuously auriculate, closely imbricate leaves. The flowers are more erect and the corollas in anthesis more in a line with the calyx."

I have not been able to find two separate taxa to match the division formalized by Eastwood among stipitate glandular plants that could be identified



Map 3. Distribution of *Castilleja auriculata* (var. *auriculata* and var. *verecunda*).

as *Castilleja auriculata* or a close relative, and (as noted above in the paragraph of taxonomic notes following *C. longiflora*), there is equal or better reason to associate *C. longiflora* with *C. tenuiflora* than with *C. auriculata*. Plants of *C. auriculata* in northern Oaxaca and immediately adjacent Puebla (the Tehuacán region, including the type locality; Map 3) produce relatively broad, mostly ascending leaves, while those in peripheral regions tend to produce narrower, spreading to descending leaves with less dense glandularity. Further, the distinctive matorral habitat of the typical plants contrasts with the more mesic habitats of those from other areas. The typical plants (*sensu stricto*) may be better treated as a separate taxon, but the difference between the two poles of variation is subtle and intergradation between them appears to be gradual. In contrast, the southwesternmost segment of *C. auriculata* can be consistently distinguished and is formally recognized.

Castilleja auriculata var. *auriculata*

Puebla, Oaxaca, Guerrero, Morelos, Edo. México, Michoacán, and Jalisco (Map 3); matorral, tropical deciduous woodlands to oak and pine-oak woodlands, often in rocky habitats, 1300-2400 m; July-January, mostly March-June in Oaxaca and Puebla.

In the area around Guadalajara, Jalisco, at the western margin of the range of var. *auriculata*, the plants approach *C. tenuiflora* in vestiture, with fewer and smaller glands and shorter and stiffer nonglandular hairs. At least some of these apparent intergrades are populational variants; one duplicate of *Pringle 8763* (from the "barranca of Guadalajara") is more like *C. auriculata* (GH) while another (WIS) is more like *C. tenuiflora*.

Castilleja auriculata var. **verecunda** Nesom, *var. nov.* TYPE: MEXICO. Jalisco: trail from San Sebastián to Arroyo Seco, near stream in canyon bottom, 1500 m, 8 Jan 1927, *Ynes Mexia 1432* (HOLOTYPE: GH!; Isotype: MICH!).

Castillejae auriculatae Eastw. typicae similis sed foliis ad bases leniter auriculatis, calycibus ac corollis brevioribus, et galea corollae hesitatione elongata differt.

Michoacán, Jalisco, Nayarit (Map 3); rocky habitats, rarely in matorral, usually in oak to oak-pine woods; 1100-2400 m; September-February.

Additional collections examined: MEXICO. Jalisco: Mpio. Cd. Guzmán, Carr. Cd. Guzmán-El Grullo, KM 21 y tomando la brecha a Media Luna, 4 km mas, 1820 m, 10 May 1988, *Fuentes O. 25* (MICH); upper E slope of Sierra de Manantlán Central, on lumber road S of San Miguel "meadows," 5-6 km due S of Rincón de Manantlán, 18-19 km S of El Chante, 2200-2400 m, 12

Jan 1980, *Iltis et al. 2619* (WIS); Mpio. Tuxpan, 32 km from Cd. Guzmán on hwy to Colima, 1980 m, 20 May 1988, *Morones G. 71* (MICH); 7-9 km W of los Sauces, road to Terreros, El Terrero, Toliman, 1850-1900 m, 30 Jan 1987, *Vazquez & Guzmán 4145* (WIS-2 sheets). Michoacán: 20.6 km W of Coalcomán, 1550 m, 17 Dec 1984, *Cowan 4906* (TEX); Dist. Aquila, 20 Jan 1942, *Hinton 16302* (LL,TEX); Dist. Coalcomán, Salitre, 1200 m, 27 Oct 1938, *Hinton 12463* (GH,MICH-2 sheets); Mpio. Coalcomán, Puerto de las Cruces, 1300 m, 24 May 1963, *Rzedowski 16667* (MICH). Nayarit: hills back of Jalisco, 11 Nov 1925, *Ferris 5495* (GH); Mpio. Jala, Volcán El Ceboruca, 12 km NE of Jalpan, 1700 m, 12 Apr 1990, *Flores F. 1874* (MICH); Mpio. Tepic, 7 km S of entrance to Cuarenteno road, 1500 m, 13 Mar 1991, *Flores F. 2517* (MICH); La Atarjea, N of Yxtlan, 1100 m, 1 Oct 1926, *Mexia 884* (GH,MICH); Cerro de San Juan, SW of Tepic, 1100-1200 m, 18-19 Aug 1935, *Pennell 19776* (GH).

Var. *verecunda* is named for the reticent behavior of the corolla, which sometimes apparently may remain within the calyx at first, with only the receptive stigma exserted. The galea itself then lengthens to become fully exserted and expose the stamens. The holotype shows this clearly, as almost all of the corollas are included within the calyces, except for the protruding stigmas. Such a tendency, however, is not as pronounced as I first thought.

Plants of var. *verecunda* are morphologically and geographically distinct from typical *Castilleja auriculata*. I have identified a number of collections as var. *verecunda* from the Coalcomán area of western Michoacán, but there appears to be some intergradation with var. *auriculata* in that area (e.g., *Hinton 16302*). Although further studies may show these two taxa to be even more distinct, the most constant morphological difference between them is the nature of the leaf insertion (see key below). The difference in calyx length is quantitative and somewhat overlapping, and I have regarded the two taxa as conspecific. Their differences are summarized in the following couplet.

1. Leaf bases slightly but distinctly auriculate, appearing clasping but immediately reduced below the auricles to a narrow insertion, without any decurrent portions; calyx 12-25 mm long, the abaxial cleft 11-16 mm deep; corollas mostly 30-34 mm long at full elongation; stigma and style exserted while corolla still included within the calyx. ... var. *verecunda*

1. Leaf bases strongly auriculate-clasping, with the margins usually distinctly short decurrent or at least broadly inserted on opposite sides of the stem; calyx (20-)24-36 mm long, the abaxial cleft 13-25 mm deep; corollas 28-40 mm long; stigma and style exserted only at full elongation of the corolla. ..... var. *auriculata*

Var. *verecunda* is superficially similar in its short calyces with more or less included corollas to another Pacific slope species of sect. *Castilleja*, *C. rhizomata* N. Holmgren. The latter, however, is stoloniferous and produces

stems only 1-3 dm tall; its stems are ridged from decurrent leaves and glandular and also very sparsely pilose with nonglandular hairs. *Castilleja auriculata* is more closely related to *C. tenuiflora* than to *C. rhizomata.*

Conspicuous glandularity of the stems and leaves has been weighted in the association of var. *verecunda* with *Castilleja auriculata*, but it also could be reasonably regarded as a variety of *C. tenuiflora.* Where the ranges of var. *verecunda* and var. *tenuiflora* are close, these two taxa appear to be more or less contiguous, not at all sympatric. Such a treatment would further emphasize the distinction of typical *C. auriculata.* Another species, at least superficially similar to *Castilleja auriculata* in its glandular leaves but perhaps more closely related to *C. tenuiflora*, is described below.

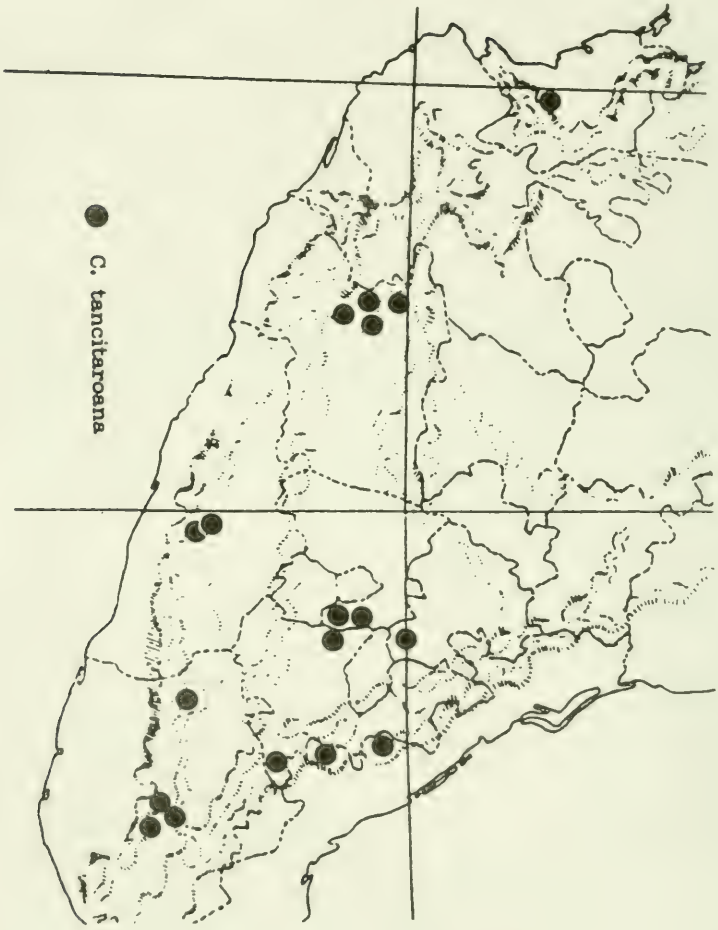
Castilleja tancitaroana Nesom, *sp. nov.* TYPE: MEXICO. Michoacán: Mpio. Ziracuaretiro, 12 km NE of Uruapan, in San Andres Coru, pine-oak woods, "someros" soils in malpais, 1710 m, 24 May 1980, *J.C. Soto N. 2211* (HOLOTYPE: TEX!; Isotype: MEXU).

Castillejae tenuiflorae Benth. similis sed foliis sparsim brevi-strigosis paginis inferis glandulosis (vs. eglandulosis) et corollarum galea tubum aequanti (vs. superanti) differt.

Perennial subshrubs, the stems woody at base, 0.8-1.5 m tall, with numerous branches, the stems and calyces hispidulous with stiff, sharp pointed, spreading-deflexed hairs 0.1-0.2 mm long, eglandular or with a few short stipitate glands. Leaves linear oblong to narrowly oblong lanceolate, 3 veined, entire, spreading-deflexed, basally ampliate and subclasping, 12-30(-45) mm long, 2-6 mm wide, upper surfaces with closely appressed nonglandular hairs ca. 0.1 mm long, lower surfaces minutely and sparsely strigose to sparsely hispidulous or without eglandular hairs, with glands barely stipitate or apparently sunken and the whole surface becoming viscid. Floral bracts lanceolate, green or the upper with a red apex, not differentiated from the upper leaves in size or shape, somewhat shorter than the calyx. Flowers sessile, in crowded terminal clusters. Calyx mostly red, stipitate glandular near the apex, 22-26 mm long, the abaxial cleft 14-17 mm long, adaxial cleft 4-8 mm long, the lateral clefts linear-lanceolate notches 1-2 mm long. Corollas yellow, 25-39 mm long, the galea 13-20 mm long, equal or slightly greater than the tube length, the dorsal surface sparsely viscid-villous or merely short stipitate glandular. Capsules ovoid, 6-9 mm long.

Nayarit, Jalisco(?), Michoacán, Guerrero, Edo. México, Dist. Federal, Hidalgo, Veracruz, Puebla, Oaxaca (Map 4); thorn-scrub to oak, pine, and fir forests, (1050-)1950-3500 m; July-March.

Additional collections examined: MEXICO. Dist. Federal: 35 mi ESE of México, 10000 ft, 24 Dec 1964, *Duncan 22410* (MICH). Hidalgo: Mpio. Apan,



Map 4. Distribution of *Castilleja tancitaroana*.

S slopes of Cerro Jihuingo, 17 km NW of Apan, 2750-3250 m, 26 Jul 1966, *West T-24* (MICH,WIS). Guerrero: 60 km W of Chichihualco on rd to Puerto del Gallo, 2180 m, 24 Nov 1983, *Barrie 715* (TEX); Dist. Mina, Cerro de los Amoles, rocky open pass, ca. 2020 m, 5 Jan 1938, *Mezia 9074* (LL); 5 mi S of Tixtla, ca. 3500 ft, 14 Jul 1952, *Rowell 3070* (MICH); Mpio. Chilpancingo, 4.7 mi E of turnoff to Omeapa on hwy 93 (Tixtla-Chilapa), 26 Oct 1984, *Saunders 1444* (LL). México (Edo.): Llano Grande, faldas del Telapon, 26 Jul 1964, *Martínez 133* (MICH); 6 km SW of Río Frio on old hwy 190, 3000 m, 27 Aug 1965, *Roe et al. 1444* (MICH); Mpio. Amecameca, 2 km NE of Santa Isabel Chalma, 2600 m, 5 Oct 1969, *Pineda R. 986* (MICH); 3 km SW of Zoyatzingo, near Amecameca, 2600 m, 9 Sep 1968, *Pineda R. 524* (MICH); N slope of Mt. Popocatepetl, 10400 ft, 24 Jul 1957, *Straw & Gregory 1023* (MICH). Michoacán: Mpio. Tancitaro, 2 mi above Tancitaro, 7000 ft and in pastures up to 11500 ft, 10 Aug 1940, *Leavenworth 533* (GH); Mpio. Tancitaro, open grassy slope of Mt. Tancitaro, 11000 ft, 19 Aug 1940, *Leavenworth 665* (GH,MICH); Mpio. Tancitaro, Mt. Tancitaro, open ridges above cloud forest, 9500 ft, 25 Jul 1941, *Leavenworth & Hoogstral 1210* (GH,MICH); Mpio. Tangancicuaro, N slope of Mt. Patamban, 9500-11000 ft, 1-4 Feb 1903, *Nelson 6587* (GH); Mpio. Uruapan, SE edge of Nuevo San Juan Parangaricutiro, ca. 13 km W of Uruapan, on malpais, 1950 m, 13 Jan 1992, *Prather 1238* (TEX); N of Uruapan on road to Paricutin, 27 Jan 1963, *Templeton 9418* (MICH); Mpio. Tangancicuaro, NW slopes of Cerro Patamban, 2800-3000 m, 20 Nov 1971, *Rzedowski & McVaugh 662* (MICH). Nayarit: Rancho San Isidro, valley of the Río Jesús María, ca. 10 km E of the village of Jesús María, W slope of the Sierra de Huichol, 1000 m, 20-21 Sep 1969, *Feddema 1440* (MICH). Oaxaca: Sierra Juárez, Cerro de Humo, 2 Mar 1945, *Alexander 831* (MICH); between Tuxtepec and Cd. Oaxaca on Hwy 175, 66 km SW of Tuxtepec, 11 Jan 1982, *Elliot 381* (WIS); Mpio. Constancia del Rosario, 3 mi S of jct to Santiago Juchtlahuaca on Rte 125 to Putla, 1320 m, 31 May 1986, *Luckow 3247* (TEX); 30 km ENE of Ayutla on road between Mitla and Zacatepec, at jct with rd to Totontepec, 2500 m, 22 Jun 1986, *Diggs et al. 3936* (TEX). Puebla: Popocatepetl, 3000 m, 11 Apr 1947, *Miranda & Barkley 17M203* (TEX); Mpio. Coxcatlán, 22 km from Coxcatlán, W of Tepeloyo, 15 Apr 1985, *Tenorio 8807* (TEX). Veracruz: 0.8 mi S on Hwy 150 (cuota) from jct with Veracruz state line, 7700 ft, 9 Jul 1990, *Jones 5312* (MICH); Mpio. Perote, La Muñeca, 2400 m, 27 Oct 1973, *Ventura A. 9194* (MICH); Maltrata, Jan 1883, *Kerber 261* (MICH).

The epithet of *Castilleja tancitaroana* reflects my first recognition of these plants as the common species in west central Michoacán, particularly in the Mount Tancitaro area. Only after annotating a number of specimens with this geographical epithet did I realize that the distribution of this species was significantly wider. The stems of *C. tancitaroana* are eglandular and usually produce strongly deflexed to spreading deflexed hairs, but these plants are rec-

ognized primarily by their glandular lower leaf surfaces and generally reduced foliar vestiture: the upper surfaces vary from glabrate to sparsely strigose with small, usually appressed, nonglandular hairs, and the lower surfaces are distinctly glandular with sunken, sessile, or short stipitate glands. When the glands are sunken, the entire lower surface becomes viscid-resinous.

Castilleja tancitaroana is completely sympatric with *C. tenuiflora* (although not nearly so widely distributed as the latter) and intermediates between the two can be found. For the most part, however, they appear to be very distinct. I have considered the possibility that *C. tancitaroana* represents only glandular variants within populations of *C. tenuiflora*. In western Michoacán, however, *C. tenuiflora* apparently is rare or absent but *C. tancitaroana* is common, and the range of *C. tenuiflora* (eglandular) extends far northward beyond that of *C. tancitaroana*. Further, the cauline vestiture of *C. tancitaroana* is more like that of *C. integrifolia* than of *C. tenuiflora*.

There is also the possibility that *Castilleja tancitaroana*, with its distinctive foliar glandularity, originated as a hybrid between *C. tenuiflora* and *C. auriculata*. If this were true, however, such a putative hybrid appears to be reproducing apart from its parents, because the ranges of *C. tancitaroana* and *C. auriculata* are different, particularly in Hidalgo, western Edo. México, and Veracruz (*C. auriculata* absent) and in southwestern Jalisco and Michoacán (*C. tancitaroana* absent). Further, the distinctive leaf insertion of *C. auriculata* (var. *auriculata*) does not appear in *C. tancitaroana*.

In summary, *Castilleja tancitaroana* and the varieties of *C. tenuiflora* and *C. auriculata* form a closely related group of plants ("the tenuiflora group"). Of these, var. *auriculata* may prove to stand apart somewhat from the others. Their differences are summarized below in the key to the taxa of sect. *Castilleja*. Clearly, the relationships among these intimately related taxa need to be studied in more detail, and field studies in areas of sympatry will be critical in refining the hypotheses presented here regarding the delimitation of taxa.

IV. Three new species peripherally related to *C. tenuiflora*

Castilleja stipifolia Nesom, sp. nov. TYPE: MEXICO. Jalisco: Cerro de Tequila, a rugged volcanic cone 13 km due S of Tequila, oak forest with scattered *Alnus* and *Arbutus*, small basaltic cliffs and in woods, 2700-2900 m, 29 Dec 1978, *H. Iltis et al. 1016* (HOLOTYPE: WIS!).

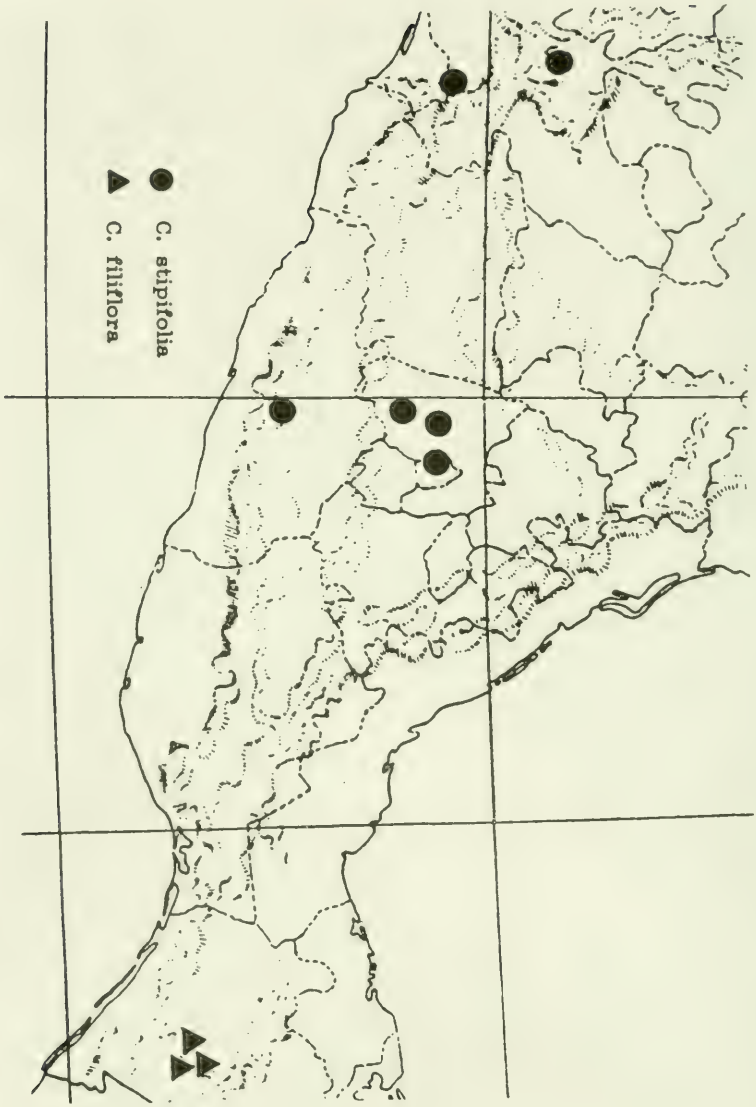
Castillejae tenuiflorae Benth. similis sed cristis demissis secus caules basibus decurrentibus foliorum exorientibus, bracteis floralibus ac caulibus in inflorescentia glandulosis, et foliis non amplectentibus parum sed distincte stipitatis differt.

Perennial herbs with many slender, ascending, woody based stems 16-30 cm tall arising from a woody taproot, the stems with low but prominent longitudinal ridges formed from decurrent leaf bases. Stems stipitate glandular in and near the inflorescence, eglandular below that and sparsely hispid with spreading to slightly deflexed hairs. Leaves spreading to slightly deflexed, moderately hispid-strigose with spreading-ascending cilia, eglandular, linear-oblong to linear-lanceolate, 10-18(-20) mm long, 1.5-2.0(-4.0) mm wide, entire or with a pair of narrow lobes, abruptly attenuate to a nonclasping base and borne on a short stipe, decurrent for the length of the internode. Floral bracts green, stipitate glandular and sparsely pilose-hirsute, entire or commonly with a pair of narrow, spreading lobes on the distal half, terminal bracts absent. Flowers 4-8 per stem, sessile or on pedicels 1-4 mm long. Calyx red to orange on the upper 2/3, (22-)24-29 mm long, abaxial cleft 14-16 mm deep, adaxial cleft 3-5 mm deep, lateral clefts notches ca. 1 mm deep. Corollas 26-38 mm long, the lower lip of 3 green, thickened teeth 1 mm long, the galea 13-22 mm long, equal or slightly longer than the tube, sparsely pilose at the apex with stipitate glandular and nonglandular hairs, long exserted from the calyx. Mature fruits not seen.

Dist. Federal, western Edo. México, Guerrero, [Michoacán?], Jalisco (Map 5); pine-fir-oak to fir woods, less commonly in mesic oak woods, 2700-3200 m; December-September or probably all year.

Additional collections examined. MEXICO: Distrito Federal: Llanos de Copilco, Cañada de Contreras, cerca del 4° Dinamo, ladera andesitica con roca volcánica, 3000 m, 5 May 1968, *J. Tirado Lizarraga s.n.* (WIS). Edo. México: Road between Toluca and Temascaltepec, ca. 45 km NE of Temascaltepec; steep N-facing slopes, 3025 m, 22 Jun 1979, *Diggs 2294* (WIS); Dist. Temascaltepec, Meson Viejo, 2830 m, 4 Apr 1933, *Hinton 3686* (MICH); N slopes of Volcán de Toluca, along road to crater, ca. 3200 m, 22 Jan 1963, *Iltis 1697* (WIS); 32 km from Toluca on road to Temascaltepec, 28 Jul 1962, *Molseed 62* (MICH). Guerrero: Near Omiltemi, 20 mi W of Chilpancingo, 7500-8000 ft, 31 Jul 1957, *Straw & Gregory 1059* (MICH). Jalisco: Cerro de Tequila, a rugged volcanic cone 13 km due S of Tequila, small basaltic cliffs and in woods, 2700-2900 m, 29 Dec 1978, *Iltis et al. 1009* (WIS); NE slopes of the Nevado de Colima, below Canoa de Leoncito, steep mountainsides, 2900-3100 m, 10 Sep 1952, *McVaugh 12872* (MICH).

Plants of *Castilleja stipifolia* have been identified mostly as *C. tenuiflora* but are immediately distinct from the latter in their nonclasping leaves decurrent as low ridges along the stems and basally attenuate to a stipitate insertion, their leaves and bracts that are sometimes lobed, and glandular upper stems. The production of leaves and bracts with conspicuous lobes and flowers with longer pedicels is variable, and further collections will be important in interpreting the extent of variability. At least superficially, *C. stipifolia* appears to be more similar in leaf morphology (decurrent, stipitate, not auriculate-



Map 5. Distribution of *Castilleja stipifolia* and *C. filiflora*.

clasping) to *C. rhizomata* N. Holmgren and *C. linifolia* N. Holmgren, endemics of Durango and Chihuahua, respectively.

Typical *Castilleja tenuiflora* is sympatric with *C. stipifolia*, although the latter apparently is much less common. I have found no records of the new species from Michoacán, but it almost certainly occurs there in habitats within pine or pine-fir woods.

Castilleja filiflora Nesom, *sp. nov.* TYPE: MEXICO. Chiapas: Mpio. Zinacantan, Barrio San Nicolas, 2910-3110 m, 24 Sep 1986, *A. Mendez Ton 9277* (HOLOTYPE: TEX!; Isotypes: CAS,MEXU).

Castillejae tapeinocladae Loesn. similis sed caulibus erectis et foliis ac bracteis floralibus lineari-lanceolatis vel filiformibus integrisque differt.

Annual or short lived perennial herbs, from slender woody roots, producing erect stems 12-35 cm tall, 3-6 or more stems arising from the base, the herbage eglandular, glabrate to sparsely invested with deflexed to antrorsely appressed hairs 0.1-0.4 mm long. Leaves entire, 3 veined, linear-lanceolate, 20-45 mm long, 0.6-2.0 mm wide, ascending, sessile, not at all basally clasping. Inflorescence on upper 1/2-1/3 of the stems; floral bracts linear to filiform, not differentiated from the upper leaves, equal to or slightly shorter than the associated calyx, green or the uppermost with red tips. Flowers separated on internodes 15-30 mm long, borne on pedicels 1-5(-12) mm long. Calyces red from base to tip, 22-28(-34) mm long, the abaxial cleft 18-22(-26) mm deep, the adaxial cleft 2-3 mm deep, lateral clefts minute notches or absent. Corollas 27-34 mm long, the lower lip of 3 thick teeth ca. 1 mm long, the galea 17-24 mm long, 60-70% of the corolla length, narrowly tubular, yellow with red flanges, densely bearded, long exserted from the calyx. Capsules ovoid, 9-15 mm long.

Additional collections examined: MEXICO. Chiapas: Mpio. San Cristóbal Las Casas, extensive marsh at S end of the valley of San Cristóbal, 2200 m, 22 May 1972, *Breedlove 25280* (LL,TEX); Mpio. Zinacantan, ridge between Paraje of Nachih and Zinacantan Center, 2350 m, 16 Aug 1976, *Breedlove 39646* (MICH); near San Cristóbal, Cerro de Guadalupe, Jun-Aug 1864-70, *Ghiesbreght 654* (GH).

All collections cited here of *Castilleja filiflora* were made in the vicinity of San Cristóbal, Chiapas (Map 5). Within sect. *Castilleja*, the species is distinguished by its small stature, thin roots, sparse vestiture, linear-lanceolate, entire, nonclasping leaves, filiform floral bracts, widely spaced flowers on relatively short pedicels, and completely red calyces with an extremely deep abaxial cleft. The epithet calls attention to the long, narrowly tubular galea.

The more recent collections of *Castilleja filiflora* were distributed as *C. tapeinoclada* Loesn., and the two are similar in their thin roots, eglandular vestiture of small, deflexed hairs, open and extended inflorescence, and corollas with a bearded, very narrow galea. While it is likely that these two species are closely related, *C. tapeinoclada* is endemic to the Guatemala highlands and comprises plants that produce prostrate stems, lobed floral bracts (the leaves also often lobed) with relatively broad midportions, and narrowly oblong-lanceolate leaves.

Castilleja perelegans Nesom, *sp. nov.* TYPE: MEXICO. Durango: Metates, N of Cueva, bushy, pine-covered crest of Sierra Madre, 2800-2900 m, 29-30 Aug 1934, *F. W. Pennell 18394* (HOLOTYPE: GH!; Isotype: MICH!).

Species novum ex affinitate *Castillejae tenuiflorae* Benth. et specierum affinium distinguenda vestimento caulorum trichomatibus patentibus crassis praecipue longis, foliis lanci-ovatis, eglandulosisque minute hispidulis, floribus longis sessilibusque, bracteis amplis obovatisque subtentis, bracteae florales ac calyces penitus rubentes, et fissuris calycis adaxialibus ac lateralibus equaliter vadosis, apicibus lobarum rotundatis.

Perennial subshrubs, stems 25-50 cm tall, erect, the lower portions slightly woody, simple or with a few branches on the lower half, sparsely and loosely villous with vitreous, flattened, eglandular hairs mostly 1-2 mm long, mixed with shorter, stipitate glandular hairs, the latter more common in the inflorescence. Leaves spreading, densely crowded on the lower stems, on internodes 1-2 cm long at midstem, lance-ovate, (3-)5 veined, mostly 3-5 cm long, 6-15 mm wide, basally subclasping but not at all auriculate, eglandular or nearly so, the lower surface hispidulous, especially along the veins and margins, the upper surface glabrate. Floral bracts spreading-ascending, the whole bract red-orange, the lowermost lance-ovate like the leaves, with an immediate transition to obovate or oblong-obovate, mostly 2.5-3.0 cm long, 7-12 mm wide. Flowers sessile, the lower separated by internodes 1.0-1.5 cm long, the upper more congested. Calyx completely red, finely villous glandular below, puberulent near the apex, slightly but distinctly curved, not at all medially constricted, 30-35 mm long, the abaxial cleft 18-20 mm deep, the adaxial and lateral clefts nearly equal in size, 2-3 mm deep, the lobes with rounded apices. Corolla yellow-green with red flanges, 36-41 mm long, the galea equal the tube length, sparsely bearded, exserted 5-9 mm from the calyx. Stigma barely expanded. Fruits broadly ovate, 8-9 mm long, 5-6 mm wide. Known only from the type collection (Map 2).

Castilleja perelegans is characterized by the following features: (1) stem vestiture of particularly long and thick, spreading hairs, (2) lance-ovate, minutely

hispidulous, eglandular leaves, (3) long, sessile flowers subtended by large, obovate bracts, the bracts and calyces completely reddish, and (4) calyces with the adaxial and lateral clefts equally shallow, the lobes with rounded apices. It is a strikingly beautiful and distinctive plant, as also recognized by Pennell, its only known collector, who identified it as the "type collection" of a name that was never published. Although it is clear that the new species is a member of sect. *Castilleja*, the nature of its relationship to the rest of the section is not apparent.

V. A new combination in Californian *Castilleja*

Chuang & Heckard (1992) have recently proposed a set of nomenclatural changes for *Castilleja* of California. One of these involves a taxon of sect. *Castilleja* that occurs in México. I agree with their assessment of variation in *C. subinclusa* E. Greene, but in order to bring the name into alignment with my other nomenclature for Mexican species, the following combination is necessary.

Castilleja subinclusa E. Greene var. **franciscana** (Penn.) Nesom, *comb. et stat. nov.* BASIONYM: *Castilleja franciscana* Penn., Proc. Acad. Nat. Sci. Philadelphia 99:188. 1947. *Castilleja subinclusa* E. Greene subsp. *franciscana* (Penn.) Chuang & Heckard, Novon 2:188. 1992.

VI. Provisional key to the Mexican and Guatemalan taxa of sect. *Castilleja* and others with an irregularly divided calyx

The taxa included in the following key include those with an irregularly cleft calyx, the abaxial cleft deep and the adaxial one shallow. Eastwood (1909) regarded *Castilleja subalpina* Eastw. as most similar to the species of sect. *Castilleja*, but the plants of the holotype (GH!) clearly belong instead with the taxa centered around *C. scorzoneraefolia* Kunth (sect. *Euchroma* [Nutt.] Benth.). The species identified in the key below as *C. pectinata* (tentatively including *C. orizabae* Benth.) and *C. purpusii*, as well as those of sect. *Epichroma*, are in need of comparative study.

Castilleja ctenodonta Eastw. and *C. altorum* Standl. & Steyerm., which apparently are sister species, are the most divergent taxa regarded here as members of sect. *Castilleja*. Eastwood (1909) treated *C. ctenodonta* within sect. *Euchroma*, noting that it is transitional to sect. *Castilleja*. Both species produce nearly pectinate leaves and a vestiture of long stipitate glands, which suggest that they might be related to sect. *Epichroma*, but their corollas have galea and tube of equal length, and the slender foliar lobes as well as the slender rhizomes are anomalous among their possible relatives.

1. Corollas with the galea equaling or longer than the tube length. ..... Sect. *Castilleja* (8)

1. Corollas with the galea ca. half the length of the tube. ..... (2)

2. Leaves pectinately divided; herbaceous annuals (4 species) from a slender taproot or perennial (1 species) from a woody root. ..... Sect. *Epichroma* Benth. (4)

2. Leaves entire; woody based perennials from woody roots. ..... the "Ortegae group." (3)

3. Stems slightly ribbed with decurrent leaf bases; leaves narrowly elliptic to linear-lanceolate; calyx with spreading, stipitate glandular and eglandular hairs; Chihuahua, Sonora, Durango, Sinaloa. .. *C. ortegae* Standley

3. Stems strongly ribbed with decurrent leaf bases; leaves linear to filiform; calyx eglandular but with short, coarse, ascending hairs; Jalisco. ..... *C. pterocaulon* N. Holmgren

4. Plants perennial; Durango, Sinaloa. ..... *C. roei* Crosswh.

4. Plants annual; Oaxaca to Jalisco. ..... (5)

5. Calyx red to orange. ..... (7)

5. Calyx yellow. ..... (6)

6. Calyx 12-17(-22) mm long; Oaxaca, Guerrero, Morelos, Edo. México, Distrito Federal. ..... *C. aurea* Rob. & Greenm.

6. Calyx 8-10 mm long; Guanajuato, Edo. México, Morelos, Oaxaca. ..... *C. gracilis* Benth.

7. Plants ca. 5-8 cm tall; floral bracts differentiated from the leaves, with the medial portion distinctly broadened rather than filiform; calyx 9-16 mm long; lower lip of corolla with teeth 2-3 mm long; Guerrero. ..... *C. venusta* Rzed.

7. Plants mostly 15-90 cm tall; floral bracts like the leaves, pinnatifid with medial portion and lobes filiform; calyx (13-)15-30 mm long; lower lip of corolla with teeth 0.5-1.0 mm long; Jalisco, Michoacán, Guerrero, Oaxaca. ..... *C. tenuifolia* Mart. & Gal.

8. Leaves and floral bracts entire. ..... (14)

8. Leaves and/or floral bracts lobed or divided. ..... (9)

9. Stems and leaves glabrous or nearly so; Sonora, southwestern United States. ..... *C. linariifolia* Benth.

9. Stems and leaves prominently hairy. .....(10)

10. Plants arising from woody roots; stems and leaves eglandular or nearly so; leaves with mostly 1-3 pairs of long lobes. .....(12)

10. Plants arising from slender rhizomes or rhizomelike caudex branches; stems and leaves with long, stipitate glandular hairs; leaves with 3-6 pairs of short, nearly filiform lobes arising from a broad midportion. .....(11)

11. Vestiture of glandular hairs only; Oaxaca. ..... *C. ctenodonta* Eastw.

11. Vestiture of glandular and eglandular hairs; Guatemala. ..... *C. altorum* Standl. & Steyerm.

12. Plants of Chihuahua, Durango, and the southwestern United States. ..... *C. patriotica* Fern.

12. Plants of southern México to Guatemala. .....(13)

13. Leaves and stems densely invested with loose, vitreous hairs mostly 1 mm long; Edo. México and Puebla (Popocatepetl and Ixtaccihuatl). ..... *C. purpusii* Brandeg.

13. Leaves and stems sparsely invested with stiff, whitish, hairs mostly 0.2-0.4 mm long, commonly deflexed on the stems; Veracruz, Puebla, Chiapas, and Guatemala. ..... *C. pectinata* Mart. & Gal.

14. Stems and leaves conspicuously hairy, sometimes also glandular. .....(16)

14. Stems and leaves glabrous or nearly so. .....(15)

15. Primary cauline leaves linear-lanceolate, the axillary filiform; calyx (20-) 23-38 mm long, glabrous to sparsely pilose with loose, spreading hairs; galea sparsely pilose bearded; Durango. ..... *C. linifolia* N. Holmgren

15. Cauline leaves filiform; calyx 16-23 mm long, glabrous; galea minutely stipitate glandular, without other hairs; Jalisco. ..... *C. macvaughii* N. Holmgren

16. Leaves mostly linear-oblong, sessile, not auriculate or decurrent; corolla with the galea shorter than the tube; California and Baja California. ..... *C. subinclusa* var. *franciscana* (Penn.) Nesom

16. Leaves auriculate and clasping or nonauriculate and sessile and then often slightly decurrent; corolla with the galea equal or longer than the tube; southeastern Arizona, México, Guatemala. ...(17)

17. Floral bracts obovate, 7-12 mm wide, completely reddish; stem hairs 1-2 mm long; southern Durango. ..... *C. perelegans* Nesom

17. Floral bracts linear, linear-lanceolate, or narrowly oblong-lanceolate, 1-5 mm wide; stem hairs less than 1 mm long. .....(18)

18. Inflorescence floriferous to the apex, without prominent, broad, apical bracts; pedicels absent or up to 6 mm long; galea variously invested. .....(21)

18. Inflorescence with an apical cluster of red bracts not associated with flowers; pedicels mostly 10-20 mm long; galea densely pilose bearded. .....(19)

19. Stems and leaves with antrorsely appressed hairs; Jalisco. .... "white-bearded *Castilleja*" Iltis & Nesom, *ined.*

19. Stems with retrorsely deflexed-appressed hairs; eastern México, primarily from Chiapas to Nuevo León and Coahuila. .....(20)

20. Stems, bracts, and calyces densely villous with loose, spreading, yellow-tinged hairs, often dense enough to completely obscure the surface; terminal bracts of the inflorescence apically lobed or toothed; Chiapas. ..... *C. chiapensis* Brandeg.

20. Stems, bracts, and calyces glabrate to sparsely hispidulous; terminal bracts of the inflorescence entire; Chiapas to Nuevo León and Coahuila (Map 2). ..... *C. integrifolia* L. *f.*

21. Plants mostly 5-12 dm tall (if shorter, from Chihuahua), roots (or rhizomes) distinctly thickened and woody; leaves and floral bracts mostly narrowly oblong; flowers usually densely congested at the stem apex. . ...(23)

21. Plants prostrate or erect and 1-4 dm tall, roots very thin; leaves narrowly lanceolate, floral bracts filiform to narrowly lanceolate; flowers loosely arranged, separated by internodes 15-30 mm long. .....(22)

22. Plants prostrate; leaves narrowly oblong-lanceolate, often lobed; floral bracts with lobes arising from a broad midportion; Guatemala. ..... *C. tapeinoclada* Loesn.

22. Plants erect; leaves linear-lanceolate, entire; floral bracts filiform; Chiapas. ..... *C. filiflora* Nesom

23. Cauline leaves basally attenuate to a nonclasping base, decurrent as thin, low ribs along the stem, the upper leaves and/or floral bracts commonly lobed; stems stipitate glandular near the inflorescence, eglandular below; Edo. México, Dist. Federal, Guerrero, and Jalisco. . *C. stipifolia* Nesom

23. Cauline leaves at least slightly auriculate at the base, clasping to subclasping, not at all decurrent, all leaves and bracts entire; stems glandular or eglandular. .....(24)

    24. Plants 1-3 dm tall, basally herbaceous, arising from rhizomes; at least the upper stems and leaves and often the whole plant stipitate glandular; southern to west central Chihuahua. .... *C. rhizomata* N. Holmgren

    24. Plants 5-12 dm tall, basally woody, arising from a woody root, without rhizomes; plants glandular or eglandular; variously distributed. ....(25)

25. Leaves glandular at least on the lower surfaces, commonly also pilose or strigose with non glandular hairs; galea ca. 1/2 the corolla length. (27)

25. Leaves eglandular, hispid-hirsute; galea ca. 2/3 the corolla length. .(26)

    26. Calyx red at least at the apex; widespread, Sonora to Coahuila and Nuevo León, south to Jalisco, Veracruz, and Oaxaca. .... *C. tenuiflora* Benth. var. *tenuiflora*

    26. Calyx yellow at least at the apex, without red coloration; Durango, Coahuila, Nuevo León, Zacatecas, and San Luis Potosí. .... *C. tenuiflora* var. *xylorrhiza* (Eastw.) Nesom

27. Stems sparsely to moderately invested with deflexed hairs mostly less than 0.2 mm long; cauline leaves relatively widely spaced along stems, without strongly developed axillary clusters; lower leaf surfaces with sunken, sessile, or short stipitate glands, usually with few other hairs, the upper surfaces glabrate to sparsely strigose with appressed, nonglandular hairs, sometimes also with sessile or short stipitate glands; calyx 22-26 mm long; Nayarit, Jalisco(?), Michoacán, Guerrero, Edo. México, Hidalgo, Veracruz, Puebla, and Oaxaca. ..... *C. tancitaroana* Nesom

27. Stems densely villous-pilose, at least some of the hairs longer than 0.5 mm; primary cauline leaves and smaller axillary clusters densely arranged on stems; upper and lower leaf surfaces densely invested with stipitate glands, commonly also with nonglandular hairs; calyx 12-36 mm long. .....(28)

    28. Leaf bases strongly auriculate clasping, with the margins usually distinctly short-decurrent or at least broadly inserted on opposite sides of the stem; calyx (20-)24-36 mm long, the abaxial cleft 13-25 mm deep; Oaxaca, Puebla, Morelos, Guerrero, Edo. México, and Michoacán. ..... *C. auriculata* Eastw. var. *auriculata*

28. Leaf bases slightly but distinctly auriculate, appearing clasping but immediately reduced below the auricles to a narrow insertion, without any decurrent portions; calyx 12-25 mm long, the abaxial cleft 11-16 mm deep; Michoacán, Jalisco, and Nayarit. .... *C. auriculata* var. *verecunda* Nesom

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TRANSFER OF *CHAETOPAPPA ELEGANS* TO *IONACTIS* (ASTERACEAE: ASTEREAE)

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ABSTRACT

Chaetopappa elegans, narrowly endemic to the White Mountains of southcentral New Mexico, is better accommodated in morphology and chromosome number within the genus *Ionactis*. The transfer is made with the nomenclatural combination **Ionactis elegans** *comb. nov.* In a review of chromosome numbers in *Chaetopappa* and *Ionactis*, it is concluded that the base numbers of the two genera are $x=8$ and $x=9$, respectively. The closest relative of *Chaetopappa* is the ditypic genus *Monoptilon* ($x=8$), while *Ionactis* is hypothesized to be a basal member of the *Heterotheca* group ($x=9$).

KEY WORDS: *Ionactis, Chaetopappa*, chromosome numbers, Astereae, Asteraceae, New Mexico

In their investigation of possibilities for the generic placement of a distinctive and previously undescribed species of the White Mountains in southcentral New Mexico, Soreng & Spellenberg (1984) reasonably narrowed to the three most likely candidates: *Chaetopappa* DC., *Ionactis* E. Greene, and *Erigeron* L. (see Nesom 1988, 1989, and Nesom & Leary 1992 for taxonomic summaries of these genera). Their choice was *Chaetopappa* (*C. elegans* Soreng & Spellenberg), initially on the basis of its strongly graduated involucres, keeled phyllaries with hyaline margins, and prominently double pappus, but also in large part apparently because they felt the species could justifiably be absorbed into a seemingly more heterogeneous *Chaetopappa* after being rejected from both *Erigeron* and *Ionactis*.

Chaetopappa elegans is unequivocally excluded from *Erigeron* by its combination of strongly carinate phyllaries, low number of disc flowers per head, disc style branches with linear-lanceolate collecting appendages and long, flexuous collecting hairs, and by its glandular achenes. Soreng & Spellenberg

(1984, p. 4) eliminated their new species from *Ionactis* on the basis of its "habit, absence of rhizomes, reduced inflorescence, nature of the chlorophyllous zone of the phyllaries, and the absence of fine scabrous pubescence." In contrast, however, *C. elegans* produces a set of characteristics that are anomalous within *Chaetopappa*: loose, crinkly stem hairs; alveolate receptacles; ray flowers with relatively long, blue (fresh), showy ligules; narrowly lanceolate style appendages of the disc flowers; strongly oblique carpopodia; a relatively large number of pappus bristles (not 5 or based on a multiple of five); and a chromosome number based on $x=9$. Except for the carpopodial morphology and chromosome number, these were noted by Soreng & Spellenberg either as anomalous within *Chaetopappa* or as characteristic of *Ionactis*. Further, as noted by Soreng & Spellenberg (p. 1), *C. elegans* occurs to the north of other *Chaetopappa* and in a different habitat. In all of these features, the species is accommodated within *Ionactis* (Nesom & Leary 1992).

With respect to the habit of *Chaetopappa elegans*, Soreng & Spellenberg (1984, p. 3) provided this description: "Densely cespitose perennial, probably from a taproot, the perennating stems from the crown slightly woody, vertically or obliquely much-forked, often subrhizomatous." *Ionactis alpina* (Nutt.) E. Greene usually is distinctly rhizomatous but sometimes may appear taprooted, and it is otherwise very similar in habit as well as inflorescence (monocephalous stems) with *C. elegans*. Close matches of phyllary morphology also are found between *C. elegans* and species of *Ionactis*. The leaf surfaces of *I. linariifolia* (L.) E. Greene sometimes are minutely, barely hispidulous and approach the other three species in this respect, although commonly the leaves are nearly as smooth as in *C. elegans*. The stem hairs of *C. elegans* are somewhat larger than in species of *Ionactis*, but they are homologous (all apparently are Type B trichomes [Nesom 1976], vs. Type A in other *Chaetopappa*).

Chaetopappa hersheyi S.F. Blake is distinctive within *Chaetopappa* (as observed by Shinners 1946, Van Horn 1973, and Soreng & Spellenberg 1984) in its compact, caespitose habit, cauline leaves densely arranged and grading into the involucral bracts, and its solitary heads. Its resemblance to *C. elegans* in these features suggests that a phylogenetic connection might be found between the two, but in diagnostic characters, especially of style appendages, pappus, and chromosome number, *C. hersheyi* is similar to other typical *Chaetopappa* and different from *C. elegans*. *Chaetopappa hersheyi* is particularly similar to *C.* (*Leucelene*) *ericoides* (Torrey) Nesom in its densely arranged, coriaceous, apically spinulose leaves with a thick, raised midvein on the lower surface, the basal leaves often persistent, and its solitary heads. The habit of the former could have been derived from the latter by a shortening of the stems with condensation of the internodes.

Ionactis is hypothesized to be a basal member of the goldenaster lineage, *Heterotheca* Cass. and its relatives (Nesom & Leary 1992). The closest relative of *Chaetopappa* appears to be the ditypic genus *Monoptilon* Torrey & Gray,

of southern California and adjacent areas, on the basis of their common production of broad, scarious margined phyllaries, white rays, short style (disc) appendages, double pappus with a very strongly differentiated inner and outer series, and base chromosome number of $x=8$. *Chaetopappa* was merged with *Pentachaeta* Nutt. by Keck (1958), but in a detailed study, Van Horn (1973) regarded them as generically distinct. Instead, *Pentachaeta* and *Tracyina* S.F. Blake are almost certainly closely related (Blake 1937; Van Horn 1973), and these two may share close ancestry with the genus *Rigiopappus* A. Gray, although the latter is somewhat anomalous in the group. Plants of all three genera are primarily Californian annuals with long style (disc) appendages, monomorphic pappus, and base chromosome numbers of $x=9$.

While *Ionactis* and *Chaetopappa* apparently are not closely related to each other within the Astereae, it is of interest to note that both have a tendency to produce sterile disc ovaries and glandular achenes, both uncommon features among other North American Astereae. In *Ionactis*, sterile disc ovaries occur only in *I. caelestis* Leary & Nesom; in *Chaetopappa*, however, a strong tendency for this occurs at least in *C. asteroides*, *C. effusa*, and *C. hersheyi*. The peculiar morphology of the disc style branches (lack of stigmatic papillae) noted in *C. effusa* by Van Horn (1973) is a concomitant of such sterility. The most significant and consistent morphological differences that distinguish *Chaetopappa* and *Ionactis* are summarized in the following couplet.

1. Stem hairs (Type A) rigid; collecting appendages of the disc style branches triangular, relatively short; achenes glabrous to sparsely strigose; carpopodium circular-symmetrical; pappus of 5 members or a multiple of 5. ..... *Chaetopappa*

1. Stem hairs (Type B) loose and crinkly; collecting appendages of the disc style branches narrowly lanceolate, relatively long; achenes sericeous to densely strigose; carpopodium oblique-asymmetrical; pappus of an irregular number of members. ..... *Ionactis*

Chromosome numbers in *Ionactis* and *Chaetopappa*

Chromosome counts based on $x=9$ have been made for three species of *Ionactis*: *I. caelestis* (Nesom & Leary 1992, $n=9$); *I. alpina* (Solbrig *et al.* 1969, $n=9$ and $n=18$; Semple 1985, $n=9$); and *I. linariifolia* (Mehra *et al.* 1965; Mehra & Remanandan 1974; Hill 1978; Jones 1980; Semple & Brouillet 1980; Semple *et al.* 1983; Semple 1985; Semple *et al.* 1992; all $n=9$). The chromosome number of *I. stenomeres* (A. Gray) E. Greene apparently has not been reported.

Nine species of *Chaetopappa*, representative of nearly the complete range of morphological variation within the genus, are known to have a chromosome number based on $x=8$. Both diploids and tetraploids are known within two species. Only *C. plomoensis* B. Turner (closely similar to *C. parryi*) and *C. keerlioides* Shinners (intermediate in some respects between *C. parryi* and *C. effusa*) remain uncounted. A complete accounting of published chromosome numbers in *Chaetopappa* is presented here.

Chaetopappa asteroides (Nutt.) DC. (Smith 1964, Van Horn 1973, Zhao & Turner in prep.; $n=8$)

Chaetopappa bellidifolia (Gray & Engelm.) Shinners (Zhao & Turner in prep.; $n=8$)

Chaetopappa bellioides (A. Gray) Shinners (Turner *et al.* 1961, Turner & Flyr 1966, Powell & Sikes 1970, Van Horn 1973, Keil & Pinkava 1976, Strother 1976, Turner 1978; $n=8$, $n=16$, $n=9(?)$ see comments below)

Chaetopappa effusa (A. Gray) Shinners (Zhao & Turner in prep.; $n=8$, see below)

Chaetopappa ericoides (Torrey) Nesom (De Jong & Longpre 1963, Solbrig *et al.* 1969, Strother 1972, Keil & Pinkava 1976, Powell & Powell 1977, Semple 1980, Strother 1983, Sundberg 1983, Ward 1983, Semple 1985, Ward & Spellenberg 1986 (34 counts), Ward & Spellenberg 1988; $n=8$, $n=16$)

Chaetopappa hersheyi S.F. Blake (Ward & Spellenberg 1986; $n=8$)

Chaetopappa imberbis (A. Gray) Nesom (reported here; $n=8$: population voucher is *Nesom 6224* [TEX] from Guadalupe County, Texas)

Chaetopappa parryi A. Gray (Zhao & Turner in prep.; $n=8$)

Chaetopappa pulchella Shinners (Turner *et al.* 1973; $n=8$) see comments below)

The previous report of $n=9$ for *Chaetopappa bellidifolia* (Solbrig *et al.* 1964) clearly was intended to refer to *C. bellidiflora* (E. Greene) Keck (= *Pentachaeta bellidiflora* E. Greene), which is endemic to a few Pacific coastal counties of California, including the locality of the voucher for the chromosome report. All taxa of *Pentachaeta* have a chromosome number of $n=9$ (Van Horn 1973); there is no aneuploid variation within the genus.

Two counts of $n=9$ have been reported for *C. bellioides* (Turner *et al.* 1961, Turner *et al.* 1973) among eight other published counts for the species of $n=8$ or $n=16$. The voucher for the 1961 count is clearly *C. bellioides* (TEX); the

voucher for the 1973 count, however, is a specimen of *C. pulchella* (TEX), and the chromosome number evidently was erroneously transcribed for publication, since the count was marked in Turner's notebook as well as on the specimen as "n=8 II." Two other counts of n=9 specifically recorded for *C. pulchella* (Turner *et al.* 1973) were in actuality counts for *Erigeron pinkavii* B. Turner (*Powell & Turner 2299* and *Turner 6010*, vouchers for both in TEX), misidentified as *C. pulchella*.

A chromosome number of n=9 was noted for *Chaetopappa effusa* by Soreng & Spellenberg (1983), and this was repeated without documentation by Nesom (1988). I have not been able to locate the original source of this report and consider the report of n=9 in error, since recent counts by Zhao & Turner (in prep.) clearly show n=8 for *C. effusa*.

In summary, the base chromosome number of *Ionactis* is x=9. More than sixty-five published chromosome counts for *Chaetopappa* have been based on x=8; only a single count remains as a bonafide report of n=9 in *Chaetopappa*, and it is in *C. bellioides*, where published counts of n=8 also exist. The most widespread and variable species in the genus (*C. ericoides*) has the greatest number of counts, and all are based on x=8. The single report of n=9 for the genus may be explained as an error in counting, the occurrence of B-chromosomes, or as a true aneuploid variant. In the last case, however, there are numerous instances of aneuploid decrease in chromosome number in the Astereae and other tribes of Asteraceae, but in the Astereae I know of no example of aneuploid increase, and such a possibility seems unlikely within *Chaetopappa*. In any case, it seems clear that the immediate ancestor of *Chaetopappa* had eight pairs of chromosomes. The chromosome number of *C. elegans* (n=9, Soreng & Spellenberg 1984) is disparate in *Chaetopappa* but not in *Ionactis*.

Transfer of *Chaetopappa elegans* to *Ionactis*

The placement of *Chaetopappa elegans* within *Ionactis*, rather than *Chaetopappa*, provides a more refined hypothesis of the evolutionary relationships of this distinctive species. The significant degree of heterogeneity added to *Chaetopappa* by its inclusion was correctly surmised by Soreng & Spellenberg, while it is easily accommodated in *Ionactis*.

Ionactis elegans (Soreng & Spellenberg) Nesom, *comb. nov.* BASIONYM: *Chaetopappa elegans* Soreng & Spellenberg, Syst. Bot. 9:1. 1984. TYPE: UNITED STATES. New Mexico: Lincoln County, Eagle Creek Canyon, on the NE flank of Sierra Blanca, 105° 45′ W, 33° 25′ N, T10S, 11 Jul 1982, *R. Soreng, R. Spellenberg, & D. Ward 2026* (HOLOTYPE: NY; Isotypes: K,NMC,TEX!).

With the addition of *Ionactis elegans*, the genus comprises five species (Nesom & Leary 1992). Within *Ionactis*, *I. elegans* is distinguished from the other taxa by a combination of characters: a relatively reduced, apparently tap rooted habit, persistent basal leaves, monocephalous stems, eglandular herbage, glabrous leaf surfaces, short disc corollas with glandular lobes, and glandular achenes. Of these features, compared to the other species, only the persistent nature of the basal leaves is unique to *I. elegans*.

Ionactis elegans is most similar to *I. alpina* and *I. stenomeres* in its monocephalous stems, cauline leaves well differentiated from the phyllaries, and phyllaries with hairy midregions. Both of the latter species are similar between themselves in long achenes (5-6 mm long, vs. 2-3 mm in the other species) and fibrous roots, and both are species primarily of the northwestern United States, separated by long distances from the geographic locality of *I. elegans*. The wide morphological divergence among all of the species of *Ionactis*, their distribution on both east and west sides of the continent, their otherwise widely disjunct distributions, and the extremely narrow (probably relictual) endemism of two of them, suggest that the active evolutionary period for the genus occurred in a relatively ancient period.

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A NEWLY RECOGNIZED SPECIES OF *DALEA* (FABACEAE) FROM NUEVO LEON, MEXICO

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ABSTRACT

Dalea eriophylla S. Wats. var. *uniflora* Barneby is represented by at least eight collections from eastcentral Nuevo León, where it is closely sympatric and nonintergrading with the typical variety. Var. *uniflora* differs from var. *eriophylla* in its narrower, revolute leaves and inflorescence reduced to a single flower, and it is elevated to species rank as **D. uniflora** *comb. et stat. nov.*

KEY WORDS: *Dalea*, Fabaceae, Nuevo León, México

Dalea eriophylla S. Wats. apparently is morphologically isolated among its relatives in sect. *Parosela* (Cav.) Barneby. Among other taxa with sessile calyces in that section, the species has been placed in series *Eriophyllae* Barneby, based on its palmately 3 foliolate (vs. pinnately compound) leaves (Barneby 1977). It is distributed from southern Coahuila through the southern half of Nuevo León and into northern San Luis Potosí (Map 1). To account for variation in vestiture of the leaves and calyx, Barneby recognized two varieties within the species, the typical variety and var. *frankenioides* Barneby, the latter known only from a single collection in the Sierra de Catorce of northwestern San Luis Potosí. He later added *D. eriophylla* var. *uniflora* Barneby (1983), more distantly separated in morphology from the other two taxa than the latter are between themselves.

Var. *uniflora* differs from var. *eriophylla* in its nearly linear, tightly revolute leaves (vs. oblanceolate to obovate, relatively flat) and inflorescence reduced to a single flower (vs. a dense, terminal spike of flowers). The former is now known from a number of localities in eastcentral Nuevo León, and judging from label data and the geology of the area where it occurs, it appears to be an obligate gypsophile. Its geographic range lies within that of var. *eriophylla* (Map 1), which occurs on substrates of both limestone and gypsum. The two taxa have

Map 1. Distribution of *Dalea eriophylla* and *Dalea uniflora*. The circled area includes the location of Cerro Grande, where the two are known to be very closely sympatric (see text). Mapped localities are drawn primarily from specimens at LL,TEX, supplemented by citations from Barneby (1977).

been collected in very close proximity on Cerro Grande in southeastern Nuevo León (var. *eriophylla* - 2050 m, 19 Oct 1986, *Hinton et al. 19091*, TEX; var. *uniflora* - 2200 m, 18 Jun 1986, *Hinton et al. 18961*, TEX), and can probably be found in similar circumstances elsewhere. No aspect of variation among specimens referable to either taxon suggests that gene flow occurs between them. The two are morphologically distinct and appear to be reproductively isolated, and they are justifiably treated as separate species.

Dalea uniflora (Barneby) Nesom, *comb. et stat. nov.* BASIONYM: *Dalea eriophylla* S. Wats. var. *uniflora* Barneby, Sida 10:14. 1983. TYPE: MEXICO. Nuevo León: Mpio. Galeana, open pine slope 4 mi S of Pablillo, 20 Jul 1958, *D.S. Correll & I.M. Johnston 19903* (HOLOTYPE: LL!).

Additional collections examined: MEXICO. Nuevo León: Mpio. Aramberri: Cerro Grande, pine woods, 2200 m, 18 Jun 1986, *Hinton et al. 18961* (TEX); near San Francisco, gypsum hillside, 1740 m, 13 May 1992, *Hinton et al. 21966* (TEX, glabrous leaves) and *21971* (TEX, puberulent leaves). Mpio. Galeana: 8 km W of Pablillo, woods of *Pinus cembroides*, 2000 m, 27 Jul 1989, *Estrada 1615* (TEX); 10 km E of Las Norias, gypsum hillside, 1960 m, 19 Jul 1984, *Hinton et al. 18752* (TEX); N of Dr. Arroyo near 100° 00′ W, 24° 30′ N, Jul 1982, *Vankat 96* (TEX). Barneby (1977) cited one additional specimen (sterile) from Mpio. Galeana: 22 mi NW of Ascensión [near Pablillo], *Shreve & Tinkham 9869* (GH), which he originally noted to be atypical and later (1983) included with var. *uniflora*.

The vestiture of *Dalea uniflora* is typically and usually puberulent with soft, crinkly-curly hairs, but the hairs may be nearly straight (e.g., *Hinton 18961*). The leaves on one of the two collections from near San Francisco (*Hinton 21966*) are completely glabrous except at the articulation of the leaflets, while leaves of the other (*Hinton 21971*) are typically puberulent. These plants appear to be identical in other features.

Barneby (1977, 1983) noted that *Dalea eriophylla* var. *frankenioides* Barneby evidently is closely sympatric with var. *eriophylla* but is distinct from it in leaf morphology and aspects of vestiture. He commented (1977, p. 459) that the vestiture of *D. eriophylla* "cannot in any sense be thought of as transitional" to var. *frankenioides*. Species rank may also prove to be more appropriate for var. *frankenioides* when more collections are available for study.

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